ZOONOMIA;

OR,

THE LAWS

OF

ORGANIC LIFE.

VOL. I.

BY ERASMUS DARWIN, M.D. F.R.S.

AUTHOR OF THE BOTANIC GARDEN.

Principio cœlum, ac terras, campoſque liquentes,
Lucentemque globum lunæ, titaniaque aſtra,
Spiritus intùs alit, totamque infuſa per artus
Mens agitat molem, et magno ſe corpore miſcet.

VIRG. Æn. vi.

Earth, on whoſe lap a thouſand nations tread,
And Ocean, brooding his prolific bed,
Night's changeful orb, blue pole, and ſilvery zones,
Where other worlds encircle other ſuns,
One Mind inhabits, one diffuſive Soul
Wields the large limbs, and mingles with the whole.

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ERRATA.

THE reader will pleaſe to excuſe an error of the corrector of the preſs—the paging from 154 to 171 is omitted, although the ſubſtance and ſubject of the work is correctly continued —and he will pleaſe to alter one figure with his pen that follows 235, by making it 236, &c. to page 250.

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DEDICATION.

TO the candid and ingenious Members of the College of Phyſicians, of the Royal Philoſophical Society, of the Two Univerſities, and to all thoſe, who ſtudy the Operations of the Mind as a Science, or who practiſe Medicine as a Profeſſion, the ſubſequent Work is,

With great Reſpect,

Inſcribed by

THE AUTHOR.

DERBY, May 1, 1794.

DEDICATION.

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TO

TO

ERASMUS DARWIN,

ON HIS WORK INTITLED

ZOONOMIA.

By DEWHURST BILSBORROW.

HAIL TO THE BARD! who ſung, from Chaos hurl'd
How ſuns and planets form'd the whirling world;
How ſphere on ſphere Earth's hidden ſtrata bend,
And caves of rock her central fires defend;
Where gems new-born their twinkling eyes unfold,
And young ores ſhoot in arboreſcent gold.
How the fair Flower, by Zephyr woo'd, unfurls
Its panting leaves, and waves its azure curls;
Or ſpreads in gay undreſs its lucid form
To meet the ſun, and ſhuts it to the ſtorm;
While in green veins impaſſion'd eddies move,
And Beauty kindles into fire and love.
How the firſt embryon-fibre, ſphere, or cube,
Lives in new forms—a line—a ring—a tube;
Cloſed in the womb with limbs unfiniſh'd laves,
Sips with rude mouth the ſalutary waves;
Seeks round its cell the ſanguine ſtreams, that paſs,
And drinks with crimſon gills the vital gas;
Weaves with ſoft threads the blue meandering vein,
The heart's red concave, and the ſilver brain;
Leads the long nerve, expands the impatient ſenſe,
And clothes in ſilken ſkin the naſcent Ens.
Erewhile, emerging from its liquid bed,
It lifts in gelid air its nodding head;
The light's firſt dawn with trembling eyelid hails,
With lungs untaught arreſts the balmy gales;
Tries its new tongue in tones unknown, and hears
The ſtrange vibrations with unpractiſed ears;

Seeks

Seeks with ſpread hands the boſom's velvet orbs,
With cloſing lips the milky fount abſorbs;
And, as compreſs'd the dulcet ſtreams diſtil,
Drinks warmth and fragrance from the living rill;—
Eyes with mute rapture every waving line,
Prints with adoring kiſs the Paphian ſhrine,
And learns erelong, the perfect form confeſs'd,
Ideal Beauty from its mother's breaſt.
Now in ſtrong lines, with bolder tints deſign'd,
You ſketch ideas, and portray the mind;
Teach how fine atoms of impinging light
To ceaſeleſs change the viſual ſenſe excite;
While the bright lens collects the rays, that ſwerve,
And bends their focus on the moving nerve.
How thoughts to thoughts are link'd with viewleſs chains,
Tribes leading tribes, and trains purſuing trains;
With ſhadowy trident how Volition guides,
Surge after ſurge, his intellectual tides;
Or, Queen of Sleep, Imagination roves
With frantic Sorrows, or delirious Loves.
Go on, O FRIEND! explore with eagle-eye;
Where wrapp'd in night retiring Cauſes lie:
Trace their ſlight bands, their ſecret haunts betray,
And give new wonders to the beam of day;
Till, link by link with ſtep aſpiring trod,
You climb from NATURE to the throne of GOD.
——So ſaw the Patriarch with admiring eyes
From earth to heaven a golden ladder riſe;
Involv'd in clouds the myſtic ſcale aſcends,
And brutes and angels crowd the diſtant ends.

Trin. Col. Cambridge,
Jan. 1, 1794.

REFERENCES TO THE WORK.

Botanic Garden, Part I.

Line 1. Canto I. l. 105.
— 3. —— IV. l. 402.
— 4. —— I. l. 140.
— 5. —— III. l. 401.
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— 9. —— I. l. 14.

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PREFACE.

THE purport of the following pages is an endeavour to reduce the facts belonging to ANIMAL LIFE into classes, orders, genera, and species; and, by comparing them with each other, to unravel the theory of diseases. It happened, perhaps unfortunately for the inquirers into the knowledge of diseases, that other sciences had received improvement previous to their own; whence, instead of comparing the properties belonging to animated nature with each other, they, idly ingenious, busied themselves in attempting to explain the laws of life by those of mechanism and chemistry; they considered the body as an hydraulic machine, and the fluids as passing through a series of chemical changes, forgetting that animation was its essential characteristic.

The great CREATOR of all things has infinitely diversified the works of his hands, but has at the same time stamped a certain similitude on the features of nature, that demonstrates to us, that *the whole is one family of one parent.* On this similitude is founded all rational analogy; which, so long as it is concerned in comparing the essential properties of bodies, leads us to many and important discoveries; but when with licentious activity it links together objects, otherwise discordant, by some fanciful similitude; it may indeed collect ornaments for wit

and poetry, but philoſophy and truth recoil from its combinations.

The want of a theory, deduced from ſuch ſtrict analogy, to conduct the practice of medicine, is lamented by its profeſſors; for, as a great number of unconnected facts are difficult to be acquired, and to be reaſoned from, the art of medicine is in many inſtances leſs efficacious under the direction of its wiſeſt practitioners; and by that buſy crowd, who either boldly wade in darkneſs, or are led into endleſs error by the glare of falſe theory, it is daily practiſed to the deſtruction of thouſands; add to this the unceaſing injury which accrues to the public by the perpetual advertiſements of pretended noſtrums; the minds of the indolent become ſuperſtitiouſly fearful of diſeaſes, which they do not labour under; and thus become the daily prey of ſome crafty empiric.

A theory founded upon nature, that ſhould bind together the ſcattered facts of medical knowledge, and converge into one point of view the laws of organic life, would thus on many accounts contribute to the intereſt of ſociety. It would capacitate men of moderate abilities to practiſe the art of healing with real advantage to the public; it would enable every one of literary acquirements to diſtinguiſh the genuine diſciples of medicine from thoſe of boaſtful effrontery, or of wily addreſs; and would teach mankind in ſome important ſituations the *knowledge of themſelves*.

There are ſome modern practitioners, who declaim againſt medical theory in general, not conſidering that to think is to theorize; and that no one can direct a method of cure to a perſon labouring under diſeaſe without thinking, that is, without theorizing; and happy therefore is the patient, whoſe phyſician poſſeſſes the beſt theory.

The

The words idea, perception, ſenſation, recollection, ſuggeſtion, and aſſociation, are each of them uſed in this treatiſe in a more limited ſenſe than in the writers of metaphyſic. The author was in doubt, whether he ſhould rather have ſubſtituted new words inſtead of them; but was at length of opinion, that new definitions of words already in uſe would be leſs burthenſome to the memory of the reader.

A great part of this work has lain by the writer above twenty years, as ſome of his friends can teſtify: he had hoped by frequent reviſion to have made it worthy the acceptance of the public; this however his other perpetual occupations have in part prevented, and may continue to prevent, as long as he may be capable of reviſing it; he therefore begs of the candid reader to accept of it in its preſent ſtate, and to excuſe any inaccuracies of expreſſion, or of concluſion, into which the intricacy of his ſubject, the general imperfection of language, or the frailty he has in common with other men, may have betrayed him; and from which he has not the vanity to believe this treatiſe to be exempt.

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SECT. I.

OF MOTION.

THE WHOLE OF NATURE may be ſuppoſed to conſiſt of two eſſences or ſubſtances; one of which may be termed ſpirit, and the other matter. The former of theſe poſſeſſes the power to commence or produce motion, and the latter to receive and communicate it. So that motion, conſidered as a cauſe, immediately precedes every effect; and, conſidered as an effect, it immediately ſucceeds every cauſe.

The MOTIONS OF MATTER may be divided into two kinds, primary and ſecondary. The ſecondary motions are thoſe which are given to or received from other matter in motion. Their laws have been ſucceſsfully inveſtigated by philoſophers in their treatiſes on mechanic powers. Theſe motions are diſtinguiſhed by this circumſtance, that the velocity multiplied into the quantity of matter of the body acted upon is equal to the velocity multiplied into the quantity of matter of the acting body.

The primary motions of matter may be divided into three claſſes, thoſe belonging to gravitation, to chemiſtry, and to life; and each claſs has its peculiar laws. Though theſe three claſſes include the motions of ſolid, liquid, and aerial bodies; there

there is nevertheleſs a fourth diviſion of motions; I mean thoſe of the ſuppoſed ethereal fluids of magnetiſm, electricity, heat, and light; whoſe properties are not ſo well inveſtigated as to be claſſed with ſufficient accuracy.

1ſt. The gravitating motions include the annual and diurnal rotation of the earth and planets, the flux and reflux of the ocean, the deſcent of heavy bodies, and other phænomena of gravitation. The unparalleled ſagacity of the great Newton has deduced the laws of this claſs of motions from the ſimple principle of the general attraction of matter. Theſe motions are diſtinguiſhed by their tendency to or from the centers of the ſun or planets.

2d. The chemical claſs of motions includes all the various appearances of chemiſtry. Many of the facts, which belong to theſe branches of ſcience, are nicely aſcertained, and elegantly claſſed; but their laws have not yet been developed from ſuch ſimple principles as thoſe above-mentioned; though it is probable, that they depend on the ſpecific attractions belonging to the particles of bodies, or to the difference of the quantity of attraction belonging to the ſides and angles of thoſe particles. The chemical notions are diſtinguiſhed by their being generally attended with an evident decompoſition or new combination of the active materials.

3d. The third claſs includes all the motions of the animal and vegetable world; as well thoſe of the veſſels, which circulate their juices, and of the muſcles, which perform their locomotion, as thoſe of the organs of ſenſe, which conſtitute their ideas.

This laſt claſs of motion is the ſubject of the following pages; which, though conſcious of their many imperfections, I hope may give ſome pleaſure to the patient reader, and contribute ſomething to the knowledge and to the cure of diſeaſes.

SECT.

SECT. II. 1.

EXPLANATIONS AND DEFINITIONS.

I. *Outline of the animal economy.*—II. 1. *Of the ſenſorium.* 2. *Of the brain and nervous medulla.* 3. *A nerve.* 4. *A muſcular fibre.* 5. *The immediate organs of ſenſe.* 6. *The external organs of ſenſe.* 7. *An idea or ſenſual motion.* 8. *Perception.* 9. *Senſation.* 10. *Recollection and ſuggeſtion.* 11. *Habit, cauſation, aſſociation, catenation.* 12. *Reflex ideas.* 13. *Stimulus defined.*

As ſome explanations and definitions will be neceſſary in the proſecution of the work, the reader is troubled with them in this place, and is intreated to keep them in his mind as he proceeds, and to take them for granted, till an apt opportunity occurs to evince their truth; to which I ſhall premiſe a very ſhort outline of the animal economy.

I.—1. THE nervous ſyſtem has its origin from the brain, and is diſtributed to every part of the body. Thoſe nerves, which ſerve the ſenſes, principally ariſe from that part of the brain, which is lodged in the head; and thoſe, which ſerve the purpoſes of muſcular motion, principally ariſe from that part of the brain, which is lodged in the neck and back, and which is erroneouſly called the ſpinal marrow. The ultimate fibrils of theſe nerves terminate in the immediate organs of ſenſe and muſcular fibres, and if a ligature be put on any part of their paſſage from the head or ſpine, all motion and perception ceaſe in the parts beneath the ligature.

2. The

2. The longitudinal muſcular fibres compoſe the locomotive muſcles, whoſe contractions move the bones of the limbs and trunk, to which their extremities are attached. The annular or ſpiral muſcular fibres compoſe the vaſcular muſcles, which conſtitute the inteſtinal canal, the arteries, veins, glands, and abſorbent veſſels.

3. The immediate organs of ſenſe, as the retina of the eye, probably conſiſt of moving fibrils, with a power of contraction ſimilar to that of the larger muſcles above deſcribed.

4. The cellular membrane conſiſts of cells, which reſemble thoſe of a ſponge, communicating with each other, and connecting together all the other parts of the body.

5. The arterial ſyſtem conſiſts of the aortal and the pulmonary artery, which are attended through their whole courſe with their correſpondent veins. The pulmonary artery receives the blood from the right chamber of the heart, and carries it to the minute extenſive ramifications of the lungs, where it is expoſed to the action of the air on a ſurface equal to that of the whole external ſkin, through the thin moiſt coats of thoſe veſſels, which are ſpread on the air-cells, which conſtitute the minute terminal ramifications of the wind-pipe. Here the blood changes its colour from a dark red to a bright ſcarlet. It is then collected by the branches of the pulmonary vein, and conveyed to the left chamber of the heart.

6. The aorta is another large artery, which receives the blood from the left chamber of the heart, after it has been thus aerated in the lungs, and conveys it by aſcending and deſcending branches to every other part of the ſyſtem; the extremities of this artery terminate either in glands, as the ſalivary glands, lacrymal glands, &c. or in capillary veſſels, which are probably leſs involuted glands; in theſe

ſome

ſome fluid, as ſaliva, tears, perſpiration, are ſeparated from the blood; and the remainder of the blood is abſorbed or drank up by branches of veins correſpondent to the branches of the artery; which are furniſhed with valves to prevent its return; and is thus carried back, after having again changed its colour to a dark red, to the right chamber of the heart. The circulation of the blood in the liver differs from this general ſyſtem; for the veins which drink up the refluent blood from thoſe arteries, which are ſpread on the bowels and meſentery, unite into a trunk in the liver, and form a kind of artery, which is branched into the whole ſubſtance of the liver, and is called the vena portarum; and from which the bile is ſeparated by the numerous hepatic glands, which conſtitute that viſcus.

7. The glands may be divided into three ſyſtems, the convoluted glands, ſuch as thoſe above deſcribed, which ſeparate bile, tears, ſaliva, &c. Secondly, the glands without convolution, as the capillary veſſels, which unite the terminations of the arteries and veins; and ſeparate both the mucus, which lubricates the cellular membrane, and the perſpirable matter, which preſerves the ſkin moiſt and flexible. And thirdly, the whole abſorbent ſyſtem, conſiſting of the lacteals, which open their mouths into the ſtomach and inteſtines, and of the lymphatics, which open their mouths on the external ſurface of the body, and on the internal linings of all the cells of the cellular membrane, and other cavities of the body.

Theſe lacteal and lymphatic veſſels are furniſhed with numerous valves to prevent the return of the fluids, which they abſorb, and terminate in glands, called lymphatic glands, and may hence be conſidered as long necks or mouths belonging to theſe glands. To theſe they convey the chyle and mucus, with a part of the perſpirable matter, and atmoſpheric moiſture; all which, after having paſſed through

through theſe glands, and having ſuffered ſome change in them, are carried forward into the blood, and ſupply perpetual nouriſhment to the ſyſtem, or replace its hourly waſte.

8. The ſtomach and inteſtinal canal have a conſtant vermicular motion, which carries forwards their contents, after the lacteals have drank up the chyle from them; and which is excited into action by the ſtimulus of the aliment we ſwallow, but which becomes occaſionally inverted or retrograde, as in vomiting, and in the iliac paſſion.

II. 1. The word *ſenſorium* in the following pages is deſigned to expreſs not only the medullary part of the brain, ſpinal marrow, nerves, organs of ſenſe, and of the muſcles; but alſo at the ſame time that living principle, or ſpirit of animation, which reſides throughout the body, without being cognizable to our ſenſes, except by its effects. The changes which occaſionally take place in the ſenſorium, as during the exertions of volition, or the ſenſations of pleaſure or pain, are termed *ſenſorial motions*.

2. The ſimilarity of the texture of the brain to that of the pancreas, and ſome other glands of the body, has induced the inquirers into this ſubject to believe, that a fluid, perhaps much more ſubtile than the electric aura, is ſeparated from the blood by that organ for the purpoſes of motion and ſenſation. When we recollect, that the electric fluid itſelf is actually accumulated and given out voluntarily by the torpedo and the gymnotus electricus, that an electric ſhock will frequently ſtimulate into motion a paralytic limb, and laſtly that it needs no perceptible tubes to convey it, this opinion ſeems not without probability; and the ſingular figure of the brain and nervous ſyſtem ſeems well adapted to diſtribute it over every part of the body.

For the medullary ſubſtance of the brain not only occupies the cavities of the head and ſpine, but paſſes

ſes along the innumerable ramifications of the nerves to the various muſcles and organs of ſenſe. In theſe it lays aſide its coverings, and is intermixed with the ſlender fibres, which conſtitute thoſe muſcles and organs of ſenſe. Thus all theſe diſtant ramifications of the ſenſorium are united at one of their extremities, that is, in the head and ſpine; and thus theſe central parts of the ſenſorium conſtitute a communication between all the organs of ſenſe and muſcles.

3. A *nerve* is a continuation of the medullary ſubſtance of the brain from the head or ſpine towards the other parts of the body, wrapped in its proper membrane.

4. The *muſcular fibres* are moving organs intermixed with that medullary ſubſtance which is continued along the nerves, as mentioned above. They are indued with the power of contraction, and are again elongated either by antagoniſt muſcles, by circulating fluids, or by elaſtic ligaments. So the muſcles on one ſide of the fore-arm bend the fingers by means of their tendons, and thoſe on the other ſide of the fore-arm extend them again. The arteries are diſtended by the circulating blood; and in the necks of quadrupeds there is a ſtrong elaſtic ligament, which aſſiſts the muſcles, which elevate the head, to keep it in its horizontal poſition, and to raiſe it after it has been depreſſed.

5. The *immediate organs of ſenſe* conſiſt in like manner of moving fibres enveloped in the medullary ſubſtance above mentioned; and are erroneouſly ſuppoſed to be ſimply an expanſion of the nervous medulla, as the retina of the eye, and the rete mucoſum of the ſkin, which are the immediate organs of viſion, and of touch. Hence when we ſpeak of the contractions of the fibrous parts of the body, we ſhall mean both the contractions of the muſcles,

muſcles, and thoſe of the immediate organs of ſenſe. Theſe *fibrous motions* are thus diſtinguiſhed from the *ſenſorial motions* above mentioned.

6. The *external organs* of ſenſe are the coverings of the immediate organs of ſenſe, and are mechanically adapted for the reception or tranſmiſſion of peculiar bodies, or of their qualities, as the cornea and humours of the eye, the tympanum of the ear, the cuticle of the fingers and tongue.

7. The word *idea* has various meanings in the writers of metaphyſic: it is here uſed ſimply for thoſe notions of external things, which our organs of ſenſe bring us acquainted with originally; and is defined a contraction, or motion, or configuration, of the fibres, which conſtitute the immediate organ of ſenſe; which will be explained at large in another part of the work. Synonymous with the word idea, we ſhall ſometimes uſe the words *ſenſual motion* in contradiſtinction to *muſcular motion*.

8. The word *perception* includes both the action of the organ of ſenſe in conſequence of the impact of external objects, and our attention to that action; that is, it expreſſes both the motion of the organ of ſenſe, or idea, and the pain or pleaſure that ſucceeds or accompanies it.

9. The pleaſure or pain which neceſſarily accompanies all thoſe perceptions or ideas which we attend to, either gradually ſubſides, or is ſucceeded by other fibrous motions. In the latter caſe it is termed *ſenſation*, as explained in Sect. V. 2, and VI. 2.—The reader is intreated to keep this in his mind, that through all this treatiſe the word ſenſation is uſed to expreſs pleaſure or pain only in its active ſtate, by whatever means it is introduced into the ſyſtem, without any reference to the ſtimulation of external objects.

10. The vulgar uſe of the word *memory* is too unlimited for our purpoſe: thoſe ideas which we voluntarily

voluntarily recall are here termed ideas of *recollection*, as when we will to repeat the alphabet backwards. And thoſe ideas which are ſuggeſted to us by preceding ideas are here termed ideas of *ſuggeſtion*, as whilſt we repeat the alphabet in the uſual order; when by habits previouſly acquired B is ſuggeſted by A, and C by B, without any effort of deliberation.

11. The word *aſſociation* properly ſignifies a ſociety or convention of things in ſome reſpects ſimilar to each other. We never ſay in common language, that the effect is aſſociated with the cauſe, though they neceſſarily accompany or ſucceed each other. Thus the contractions of our muſcles and organs of ſenſe may be ſaid to be aſſociated together, but cannot with propriety be ſaid to be aſſociated with irritations, or with volition, or with ſenſation; becauſe they are cauſed by them, as mentioned in Sect. IV. When fibrous contractions ſucceed other fibrous contractions, the connection is termed *aſſociation*; when fibrous contractions ſucceed ſenſorial motions, the connection is termed *cauſation*; when fibrous and ſenſorial motions reciprocally introduce each other in progreſſive trains or tribes, it is termed *catenation* of animal motions. All theſe connections are ſaid to be produced by *habit*; that is, by frequent repetition.

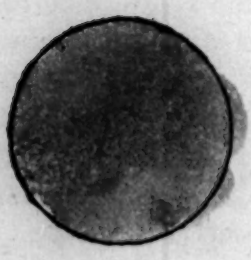
12. It may be proper to obſerve, that by the unavoidable idiom of our language the ideas of perception, of recollection, or of imagination, in the plural number ſignify the ideas belonging to perception, to recollection, or to imagination; whilſt the idea of perception, of recollection, or of imagination, in the ſingular number is uſed for what is termed "a reflex idea of any of thoſe operations of the ſenſorium."

13. By the word *ſtimulus* is not only meant the application of external bodies to our organs of ſenſe and

and muſcular fibres, which excites into action the ſenſorial power termed irritation; but alſo pleaſure or pain, when they excite into action the ſenſorial power termed ſenſation; and deſire or averſion, when they excite into action the power of volition; and laſtly, the fibrous contractions which precede aſſociation; as is further explained in Sect. XII. 2. 1.

SECT.





SECT. III.

THE MOTIONS OF THE RETINA DEMONSTRATED BY EXPERIMENTS.

I. *Of animal motions and of ideas.* II. *The fibrous ſtructure of the retina.* III. *The activity of the retina in viſion.* 1. *Rays of light have no momentum.* 2. *Objects long viewed become fainter.* 3. *Spectra of black objects become luminous.* 4. *Varying ſpectra from gyration.* 5. *From long inſpection of various colours.* IV. *Motions of the organs of ſenſe conſtitute ideas.* 1. *Light from preſſing the eye-ball, and ſound from the pulſation of the carotid artery.* 2. *Ideas in ſleep miſtaken for perceptions.* 3. *Ideas of imagination produce pain and ſickneſs like ſenſations.* 4. *When the organ of ſenſe is deſtroyed, the ideas belonging to that ſenſe periſh.* V. *Analogy between muſcular motions and ſenſual motions, or ideas.* 1. *They are both originally excited by irritations.* 2. *And aſſociated together in the ſame manner.* 3. *Both act in nearly the ſame times.* 4. *Are alike ſtrengthened or fatigued by exerciſe.* 5. *Are alike painful from inflammation.* 6. *Are alike benumbed by compreſſion.* 7. *Are alike liable to paralyſis.* 8. *To convulſion.* 9. *To the influence of old age.* VI. *Objections anſwered.* 1. *Why we cannot invent new ideas.* 2. *If ideas reſemble external objects.* 3. *Of the imagined ſenſation in an amputated limb.* 4. *Abſtract ideas.* VII. *What are ideas, if they are not animal motions?*

BEFORE the great variety of animal motions can be duly arranged into natural claſſes and orders, it is neceſſary to ſmooth the way to this yet unconquered field of ſcience, by removing ſome obſtacles

which thwart our paſſage. I. To demonſtrate that the retina and other immediate organs of ſenſe poſſeſs a power of motion, and that theſe motions conſtitute our ideas, according to the fifth and ſeventh of the preceding aſſertions, claims our firſt attention.

Animal motions are diſtinguiſhed from the communicated motions, mentioned in the firſt ſection, as they have no mechanical proportion to their cauſe; for the goad of a ſpur on the ſkin of a horſe ſhall induce him to move a load of hay. They differ from the gravitating motions there mentioned, as they are exerted with equal facility in all directions, and they differ from the chemical claſs of motions, becauſe no apparent decompoſitions or new combinations are produced in the moving materials.

Hence, when we ſay, animal motion is excited by irritation, we do not mean that the motion bears any proportion to the mechanical impulſe of the ſtimulus; nor that it is affected by the general gravitation of the two bodies; nor by their chemical properties, but ſolely that certain animal fibres are excited into action by ſomething external to the moving organ.

In this ſenſe the ſtimulus of the blood produces the contractions of the heart; and the ſubſtances we take into our ſtomach and bowels irritate them to perform their neceſſary functions. The rays of light excite the retina into animal motion by their ſtimulus; at the ſame time that thoſe rays of light themſelves are phyſically converged to a focus by the inactive humours of the eye. The vibrations of the air ſtimulate the auditory nerve into animal action; while it is probable that the tympanum of the ear at the ſame time undergoes a mechanical vibration.

To

To render this circumſtance more eaſy to be comprehended, *motion may be defined to be a variation of figure*; for the whole univerſe may be conſidered as one thing poſſeſſing a certain figure; the motions of any of its parts are a variation of this figure of the whole: this definition of motion will be further explained in Section XIV. 2. 2. on the production of ideas.

Now the motions of an organ of ſenſe are a ſucceſſion of configurations of that organ; theſe configurations ſucceed each other quicker or ſlower; and whatever configuration of this organ of ſenſe, that is, whatever portion of the motion of it is, or has uſually been, attended to, conſtitutes an idea. Hence the configuration is not to be conſidered as an effect of the motion of the organ, but rather as a part or temporary termination of it; and that, whether a pauſe ſucceeds it, or a configuration immediately takes place. Thus when a ſucceſſion of moving objects are preſented to our view, the ideas of trumpets, horns, lords and ladies, trains and canopies, are configurations, that is, parts or links of the ſucceſſive motions of the organ of viſion.

Theſe motions or configurations of the organs of ſenſe differ from the ſenſorial motions to be deſcribed hereafter, as they appear to be ſimply contractions of the fibrous extremities of thoſe organs, and in that reſpect exactly reſemble the motions or contractions of the larger muſcles, as appears from the following experiment. Place a circular piece of red ſilk about an inch in diameter on a ſheet of white paper in a ſtrong light, as in Plate I.—look for a minute on this area, or till the eye becomes ſomewhat fatigued, and then, gently cloſing your eyes, and ſhading them with your hand, a circular green area of the ſame apparent diameter becomes viſible in the cloſed eye. This green area is the colour reverſe to the red area, which had been previouſly

inſpected, as explained in the experiments on ocular ſpectra at the end of the work, and in Botanical Garden, P. I. additional note, No. I. Hence it appears, that a part of the retina, which had been fatigued by contraction in one direction, relieves itſelf by exerting the antagoniſt fibres, and producing a contraction in an oppoſite direction, as is common in the exertions of our muſcles. Thus when we are tired with long action of our arms in one direction, as in holding a bridle on a journey, we occaſionally throw them into an oppoſite poſition to relieve the fatigued muſcles.

Mr. Locke has defined an idea to be "whatever is preſent to the mind;" but this would include the exertions of volition, and the ſenſations of pleaſure and pain, as well as thoſe operations of our ſyſtem, which acquaint us with external objects; and is therefore too unlimited for our purpoſe. Mr. Locke ſeems to have fallen into a further error, by conceiving, that the mind could form a general or abſtract idea by its own operation, which was the copy of no particular perception; as of a triangle in general, that was neither acute, obtuſe, nor right angled. The ingenious Dr. Berkley and Mr. Hume have demonſtrated, that ſuch general ideas have no exiſtence in nature, not even in the mind of their celebrated inventor. We ſhall therefore take for granted at preſent, that our recollection or imagination of external objects conſiſts of a partial repetition of the perceptions, which were excited by thoſe external objects, at the time we became acquainted with them; and that our reflex ideas of the operations of our minds are partial repetitions of thoſe operations.

II. The following article evinces that the organ of viſion conſiſts of a fibrous part as well as of the nervous medulla, like other white muſcles; and hence, as it reſembles the muſcular parts of the body

body in its ſtructure, we may conclude, that it muſt reſemble them in poſſeſſing a power of being excited into animal motion.—The ſubſequent experiments on the optic nerve, and on the colours remaining in the eye, are copied from a paper on ocular ſpectra publiſhed in the ſeventy-ſixth volume of the Philoſ. Tranſ. by Dr. R. Darwin of Shrewſbury; which, as I ſhall have frequent occaſion to refer to, is reprinted in this work, Sect. XL. The retina of an ox's eye was ſuſpended in a glaſs of warm water, and forcibly torn in a few places; the edges of theſe parts appeared jagged and hairy, and did not contract and become ſmooth like ſimple mucus, when it is diſtended till it breaks; which evinced that it conſiſted of fibres. This fibrous conſtruction became ſtill more diſtinct to the ſight by adding ſome cauſtic alcali to the water; as the adhering mucus was firſt eroded, and the hair-like fibres remained floating in the veſſel. Nor does the degree of tranſparency of the retina invalidate this evidence of its fibrous ſtructure, ſince Leeuwenhoek has ſhewn, that the cryſtalline humour itſelf conſiſts of fibres. Arc. Nat. V. I. 70.

Hence it appears, that as the muſcles conſiſt of larger fibres intermixed with a ſmaller quantity of nervous medulla, the organ of viſion conſiſts of a greater quantity of nervous medulla intermixed with ſmaller fibres. It is probable that the locomotive muſcles of microſcopic animals may have greater tenuity than thoſe of the retina; and there is reaſon to conclude from analogy, that the other immediate organs of ſenſe, as the portio mollis of the auditory nerve, and the rete mucoſum of the ſkin, poſſeſs a ſimilarity of ſtructure with the retina, and a ſimilar power of being excited into animal motion.

III. The ſubſequent articles ſhew, that neither mechanical impreſſions, nor chemical combinations of

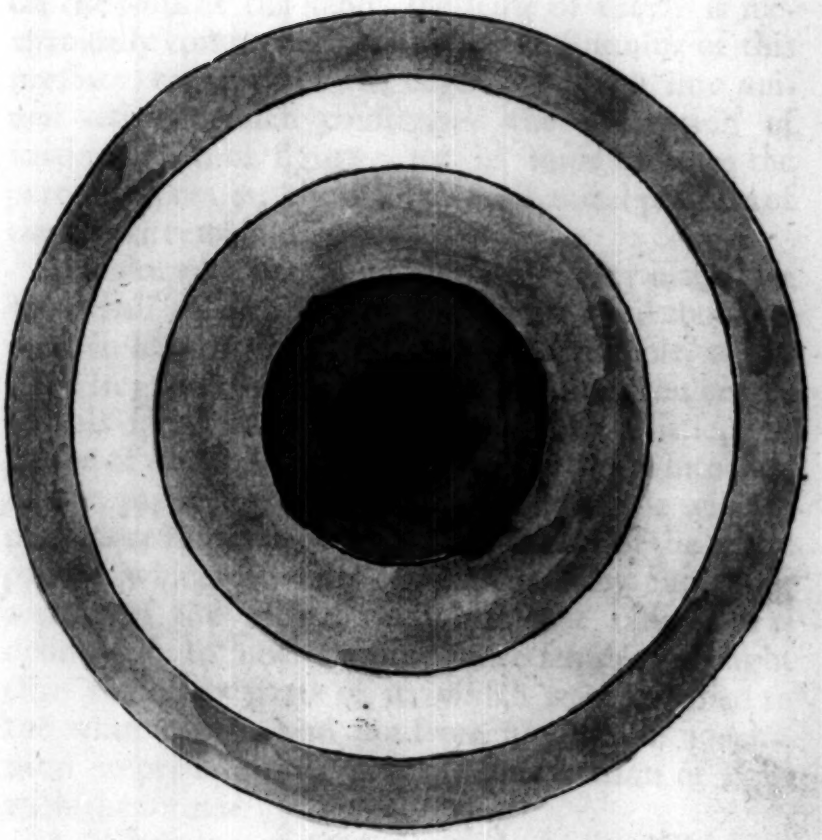
of light, but that the animal activity of the retina conſtitutes viſion.

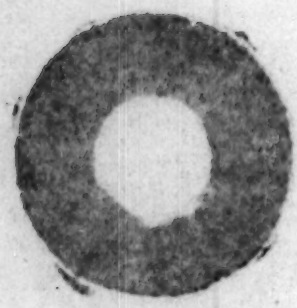
1. Much has been conjectured by philoſophers about the momentum of the rays of light; to ſubject this to experiment a very light horizontal balance was conſtructed by Mr. Michel, with about an inch ſquare of thin leaf-copper ſuſpended at each end of it, as deſcribed in Dr. Prieſtley's Hiſtory of Light and Colours. The focus of a very large convex mirror was thrown by Dr. Powel, in his lectures on experimental philoſophy, in my preſence, on one wing of this delicate balance, and it receded from the light; thrown on the other wing, it approached towards the light, and this repeatedly; ſo that no ſenſible impulſe could be obſerved, but what might well be aſcribed to the aſcent of heated air.

Whence it is reaſonable to conclude, that the light of the day muſt be much too weak in its dilute ſtate to make any mechanical impreſſion on ſo tenacious a ſubſtance as the retina of the eye.—Add to this, that as the retina is nearly tranſparent, it could therefore make leſs reſiſtance to the mechanical impulſe of light; which, according to the obſervations related by Mr. Melvil in the Edinburgh Literary Eſſays, only communicates heat, and ſhould therefore only communicate momentum, where it is obſtructed, reflected, or refracted.—From whence alſo may be collected the final cauſe of this degree of tranſparency of the retina, viz. leſt by the focus of ſtronger lights, heat and pain ſhould have been produced in the retina, inſtead of that ſtimulus which excites it into animal motion.

2. On looking long on an area of ſcarlet ſilk of about an inch in diameter laid on white paper, as in Plate I. the ſcarlet colour becomes fainter, till at length it entirely vaniſhes, though the eye is kept uniformly and ſteadily upon it. Now if the change or motion of the retina was a mechanical impreſſi-

on,





on, or a chemical tinge of coloured light, the perception would every minute become ſtronger and ſtronger—whereas in this experiment it becomes every inſtant weaker and weaker. The ſame circumſtance obtains in the continued application of ſound, or of ſapid bodies, or of odorous ones, or of tangible ones, to their adapted organs of ſenſe.

Thus when a circular coin, as a ſhilling, is preſſed on the palm of the hand, the ſenſe of touch is mechanically compreſſed; but it is the ſtimulus of this preſſure that excites the organ of touch into animal action, which conſtitutes the perception of hardneſs and of figure: for in ſome minutes the perception ceaſes, though the mechanical preſſure of the object remains.

3. Make with ink on white paper a very black ſpot about half an inch in diameter, with a tail about an inch in length, ſo as to reſemble a tadpole, as in Plate II.; look ſtedfaſtly for a minute on the center of this ſpot, and on moving the eye a little, the figure of the tadpole will be ſeen on the white part of the paper; which figure of the tadpole will appear more luminous than the other part of the white paper; which can only be explained by ſuppoſing a part of the retina, on which the tadpole was delineated, to have become more ſenſible to light than the other parts of it, which were expoſed to the white paper; and not from any idea of mechanical impreſſion or chemical combination of light with the retina.

4. When any one turns round rapidly, till he becomes dizzy, and falls upon the ground, the ſpectra of the ambient objects continue to preſent themſelves in rotation, and he ſeems to behold the objects ſtill in motion. Now if theſe ſpectra were impreſſions on a paſſive organ, they either muſt continue as they were received laſt, or not continue at all.

5. Place

5. Place a piece of red ſilk about an inch in diameter on a ſheet of white paper in a ſtrong light, as in Plate I.; look ſteadily upon it from the diſtance of about half a yard for a minute; then cloſing your eye-lids, cover them with your hands and handkerchief, and a green ſpectrum will be ſeen in your eyes reſembling in form the piece of red ſilk. After ſome ſeconds of time the ſpectrum will diſappear, and in a few more ſeconds will reappear; and thus alternately three or four times, if the experiment be well made, till at length it vaniſhes entirely.

6. Place a circular piece of white paper, about four inches in diameter, in the ſunſhine, cover the center of this with a circular piece of black ſilk, about three inches in diameter; and the center of the black ſilk with a circle of pink ſilk, about two inches in diameter; and the center of the pink ſilk with a circle of yellow ſilk, about one inch in diameter; and the center of this with a circle of blue ſilk, about half an inch in diameter; make a ſmall ſpot with ink in the center of the blue ſilk, as in Plate III. look ſteadily for a minute on this central ſpot, and then cloſing your eyes, and applying your hand at about an inch diſtance before them, ſo as to prevent too much or too little light from paſſing through the eye-lids, and you will ſee the moſt beautiful circles of colours that imagination can conceive; which are moſt reſembled by the colours occaſioned by pouring a drop or two of oil on a ſtill lake in a bright day. But theſe circular iriſes of colours are not only different from the colours of the ſilks above mentioned, but are at the ſame time perpetually changing as long as they exiſt.

From all theſe experiments it appears, that theſe ſpectra in the eye are not owing to the mechanical impulſe of light impreſſed on the retina; nor to its chemical combination with that organ; nor to the abſorption and emiſſion of light; as is ſuppoſed perhaps



perhaps erroneouſly, to take place in calcined ſhells and other phoſphoreſcent bodies, after having been expoſed to the light: for in all theſe caſes the ſpectra in the eye ſhould either remain of the ſame colour, or gradually decay, when the object is withdrawn; and neither their evaneſcence during the preſence of their object, as in the ſecond experiment, nor their change from dark to luminous, as in the third experiment, nor their rotation, as in the fourth experiment, nor the alternate preſence and evaneſcence of them, as in the fifth experiment, nor the perpetual change of colours of them, as in the laſt experiment, could exiſt.

IV. The ſubſequent articles ſhew, that theſe animal motions or configurations of our organs of ſenſe conſtitute our ideas.

1. If any one in the dark preſſes the ball of his eye, by applying his finger to the external corner of it, a luminous appearance is obſerved; and by a ſmart ſtroke on the eye great flaſhes of fire are perceived. (Newton's Optics.) So that when the arteries, that are near the auditory nerve, make ſtronger pulſations than uſual, as in ſome fevers, an undulating ſound is excited in the ears. Hence it is not the preſence of the light and ſound, but the motions of the organ, that are immediately neceſſary to conſtitute the perception or idea of light and ſound.

2. During the time of ſleep, or in delirium, the ideas of imagination are miſtaken for the perceptions of external objects; whence it appears, that theſe ideas of imagination are no other than a reiteration of thoſe motions of the organs of ſenſe, which were originally excited by the ſtimulus of external objects: and in our waking hours the ſimple ideas, that we call up by recollection or by imagination, as the colour of red, or the ſmell of a roſe,

a roſe, are exact reſemblances of the ſame ſimple ideas from perception; and in conſequence muſt be a repetition of thoſe very motions.

3. The diſagreeable ſenſation called the tooth-edge is originally excited by the painful jarring of the teeth in biting the edge of the glaſs, or porcelain cup, in which our food was given us in our infancy, as is further explained in the Section XVI. 10, on Inſtinct.—This diſagreeable ſenſation is afterwards excitable not only by a repetition of the ſound, that was then produced, but by imagination alone, as I have myſelf frequently experienced; in this caſe the idea of biting a china cup, when I imagine it very diſtinctly, or when I ſee another perſon bite a cup or glaſs, excites an actual pain in the nerves of my teeth. So that this idea and pain ſeem to be nothing more than the reiterated motions of thoſe nerves, that were formerly ſo diſagreeably affected.

Other ideas that are excited by imagination or recollection in many inſtances produce ſimilar effects on the conſtitution, as our perceptions had formerly produced, and are therefore undoubtedly a repetition of the ſame motions. A ſtory which the celebrated Baron Van Swieten relates of himſelf is to this purpoſe. He was preſent when the putrid carcaſe of a dead dog exploded with prodigious ſtench; and ſome years afterwards, accidentally riding along the ſame road, he was thrown into the ſame ſickneſs and vomiting by the idea of the ſtench, as he had before experienced from the perception of it.

4. Where the organ of ſenſe is totally deſtroyed, the ideas which were received by that organ ſeem to periſh along with it, as well as the power of perception. Of this a ſatisfactory inſtance has fallen under my obſervation. A gentleman about ſixty years of age had been totally deaf for near thirty years:

years: he appeared to be a man of good underſtanding, and amuſed himſelf with reading, and by converſing either by the uſe of the pen, or by ſigns made with his fingers, to repreſent letters. I obſerved that he had ſo far forgot the pronunciation of the language, that when he attempted to ſpeak, none of his words had diſtinct articulation, though his relations could ſometimes underſtand his meaning. But, which is much to the point, he aſſured me, that in his dreams he always imagined that people converſed with him by ſigns or writing, and never that he heard any one ſpeak to him. From hence it appears, that with the perceptions of ſounds he has alſo loſt the idea of them; though the organs of ſpeech ſtill retain ſomewhat of their uſual habits of articulation.

This obſervation may throw ſome light on the medical treatment of deaf people; as it may be learnt from their dreams, whether the auditory nerve be paralytic, or their deafneſs be owing to ſome defect of the external organ.

It rarely happens that the immediate organ of viſion is perfectly deſtroyed. The moſt frequent cauſes of blindneſs are occaſioned by defects of the external organ, as in cataracts and obfuſcations of the cornea. But I have had the opportunity of converſing with two men, who had been ſome years blind; one of them had a complete gutta ſerena, and the other had loſt the whole ſubſtance of his eyes. They both told me that they did not remember to have ever dreamt of viſible objects, ſince the total loſs of their ſight.

V. Another method of diſcovering that our ideas are animal motions of the organs of ſenſe, is from conſidering the great analogy they bear to the motions of the larger muſcles of the body. In the following articles it will appear that they are originally excited into action by the irritation of external

ternal objects like our muſcles; are aſſociated together like our muſcular motions; act in ſimilar time with them; are fatigued by continual exertion like them; and that the organs of ſenſe are ſubject to inflammation, numbneſs, palſy, convulſion, and the defects of old age, in the ſame manner as the muſcular fibres.

1. All our perceptions or ideas of external objects are univerſally allowed to have been originally excited by the ſtimulus of thoſe external objects; and it will be ſhewn in a ſucceeding ſection, that it is probable that all our muſcular motions, as well thoſe that are become voluntary as thoſe of the heart and glandular ſyſtem, were originally in like manner excited by the ſtimulus of ſomething external to the organ of motion.

2. Our ideas are alſo aſſociated together after their production preciſely in the ſame manner as our muſcular motions; which will likewiſe be fully explained in the ſucceeding ſection.

3. The time taken up in performing an idea is likewiſe much the ſame as that taken up in performing a muſcular motion. A muſician can preſs the keys of an harpſichord with his fingers in the order of a tune he has been accuſtomed to play, in as little time as he can run over thoſe notes in his mind. So we many times in an hour cover our eyeballs with our eye-lids without perceiving that we are in the dark; hence the perception or idea of light is not changed for that of darkneſs in ſo ſmall a time as the twinkling of an eye; ſo that in this caſe the muſcular motion of the eye-lid is performed quicker than the perception of light can be changed for that of darkneſs.—So if a fire-ſtick be whirled round in the dark, a luminous circle appears to the obſerver; if it be whirled ſomewhat ſlower, this circle becomes interrupted in one part; and then the time taken up in ſuch a revolution of the

the ſtick is the ſame that the obſerver uſes in changing his ideas: thus the δολιχοσκιον εγχος of Homer, the long ſhadow of the flying javelin, is elegantly deſigned to give us an idea of its velocity, and not of its length.

4. The fatigue that follows a continued attention of the mind to one object is relieved by changing the ſubject of our thoughts; as the continued movement of one limb is relieved by moving another in its ſtead. Whereas a due exerciſe of the faculties of the mind ſtrengthens and improves thoſe faculties, whether of imagination or recollection; as the exerciſe of our limbs in dancing or fencing increaſes the ſtrength and agility of the muſcles thus employed.

5. If the muſcles of any limb are inflamed, they do not move without pain; ſo when the retina is inflamed, its motions alſo are painful. Hence light is as intolerable in this kind of ophthalmia, as preſſure is to the finger in the paronychia. In this diſeaſe the patients frequently dream of having their eyes painfully dazzled; hence the idea of ſtrong light is painful as well as the reality. The firſt of theſe facts evinces that our perceptions are motions of the organs of ſenſe; and the latter, that our imaginations are alſo motions of the ſame organs.

6. The organs of ſenſe, like the moving muſcles, are liable to become benumbed, or leſs ſenſible, from compreſſion. Thus, if any perſon on a light day looks on a white wall, he may perceive the ramifications of the optic artery, at every pulſation of it, repreſented by darker branches on the white wall; which is evidently owing to its compreſſing the retinue during the diaſtole of the artery. Savage Noſolog.

7. The organs of ſenſe and the moving muſcles are alike liable to be affected with palſy, as in the

gutta ſerena, and in ſome caſes of deafneſs; and one ſide of the face has ſometimes loſt its power of ſenſation, but retained its power of motion; other parts of the body have loſt their motions but retained their ſenſation, as in the common hemiplagia; and in other inſtances both theſe powers have periſhed together.

8. In ſome convulſive diſeaſes a delirium or inſanity ſupervenes, and the convulſions ceaſe; and converſely the convulſions ſhall ſupervene, and the delirium ceaſe. Of this I have been a witneſs many times in a day in the paroxyſms of violent epilepſies; which evinces that one kind of delirium is a convulſion of the organs of ſenſe, and that our ideas are the motions of theſe organs: the ſubſequent caſes will illuſtrate this obſervation.

Miſs G——, a fair young lady, with light eyes and hair, was ſeized with moſt violent convulſions of her limbs, with outrageous hiccough, and moſt vehement efforts to vomit: after near an hour was elapſed this tragedy ceaſed, and a calm talkative delirium ſupervened for about another hour; and theſe relieved each other at intervals during the greateſt part of three or four days. After having carefully conſidered this diſeaſe, I thought the convulſions of her ideas leſs dangerous than thoſe of her muſcles; and having in vain attempted to make any opiate continue in her ſtomach, an ounce of laudanum was rubbed along the ſpine of her back, and a dram of it was uſed as an enema; by this medicine a kind of drunken delirium was continued many hours; and when it ceaſed the convulſions did not return; and the lady continued well many years, except ſome ſlighter relapſes, which were relieved in the ſame manner.

Miſs H——, an accompliſhed young lady, with light eyes and hair, was ſeized with convulſions of her limbs, with hiccough, and efforts to vomit, more

more violent than words can expreſs; theſe continued near an hour, and were ſucceeded with a cataleptic ſpaſm of one arm, with the hand applied to her head; and after about twenty minutes theſe ſpaſms ceaſed, and a talkative reverie ſupervened for near another hour, from which no violence, which it was proper to uſe, could awaken her. Theſe periods of convulſions, firſt of the muſcles, and then of the ideas, returned twice a day for ſeveral weeks; and were at length removed by great doſes of opium, after a great variety of other medicines and applications had been in vain experienced. This lady was ſubject to frequent relapſes, once or twice a year for many years, and was as frequently relieved by the ſame method.

Miſs W———, an elegant young lady, with black eyes and hair, had ſometimes a violent pain of her ſide, at other times a moſt painful ſtrangury, which were every day ſucceeded by delirium; which gave a temporary relief to the painful ſpaſms. After the vain exhibition of variety of medicines and applications by different phyſicians, for more than a twelvemonth, ſhe was directed to take ſome doſes of opium, which were gradually increaſed, by which a drunken delirium was kept up for a day or two, and the pains prevented from returning. A fleſh diet, with a little wine or beer, inſtead of the low regimen ſhe had previouſly uſed, in a few weeks completely eſtabliſhed her health; which, except a few relapſes, has continued for many years.

9. Laſtly, as we advance in life all the parts of the body become more rigid, and are rendered leſs ſuſceptible of new habits of motion, though they retain thoſe that were before eſtabliſhed. This is ſenſibly obſerved by thoſe who apply themſelves late in life to muſic, fencing, or any of the mechanic arts. In the ſame manner many elderly peo-

ple retain the ideas they had learned early in life, but find great difficulty in acquiring new trains of memory; inſomuch that in extreme old age we frequently ſee a forgetfulneſs of the buſineſs of yeſterday, and at the ſame time a circumſtantial remembrance of the amuſements of their youth; till at length the ideas of recollection and activity of the body gradually ceaſe together—ſuch is the condition of humanity!—and nothing remains but the vital motions and ſenſations.

VI. 1. In oppoſition to this doctrine of the production of our ideas, it may be aſked, if ſome of our ideas, like other animal motions, are voluntary, why can we not invent new ones, that have not been received by perception? The anſwer will be better underſtood after having peruſed the ſucceeding ſection, where it will be explained, that the muſcular motions likewiſe are originally excited by the ſtimulus of bodies external to the moving organ; and that the will has only the power of repeating the motions thus excited.

2. Another objector may aſk, Can the motion of an organ of ſenſe reſemble an odour or a colour? To which I can only anſwer, that it has not been demonſtrated that any of our ideas reſemble the objects that excite them: it has generally been believed that they do not; but this ſhall be diſcuſſed at large in Sect. XIV.

5. There is another objection that at firſt view would ſeem leſs eaſy to ſurmount. After the amputation of a foot or a finger, it has frequently happened, that an injury being offered to the ſtump of the amputated limb, whether from cold air, too great preſſure, or other accidents, the patient has complained of a ſenſation of pain in the foot or finger, that was cut off. Does not this evince that all our ideas are excited in the brain, and not in the organs of ſenſe? This objection is anſwered, by

by obſerving that our ideas of the ſhape, place, and ſolidity of our limbs, are acquired by our organs of touch and of ſight, which are ſituated in our fingers and eyes, and not by any ſenſations in the limb itſelf.

In this caſe the pain or ſenſation, which formerly has ariſen in the foot or toes, and been propagated along the nerves to the central part of the ſenſorium, was at the ſame time accompanied with a viſible idea of the ſhape and place, and with a tangible idea of the ſolidity of the affected limb: now when theſe nerves are afterwards affected by any injury done to the remaining ſtump with a ſimilar degree or kind of pain, the ideas of the ſhape, place, or ſolidity of the loſt limb, return by aſſociation; as theſe ideas belong to the organs of ſight and touch, on which they were firſt excited.

4. If you wonder what organs of ſenſe can be excited into motion, when you call up the ideas of wiſdom or benevolence, which Mr. Locke has termed abſtracted ideas; I aſk you by what organs of ſenſe you firſt became acquainted with theſe ideas? And the anſwer will be reciprocal; for it is certain that all our ideas were originally acquired by our organs of ſenſe; for whatever excites our perception muſt be external to the organ that perceives it, and we have no other inlets to knowledge but by our perceptions: as will be further explained in Section XIV. and XV. on the Productions and Claſſes of Ideas.

VII. If our recollection or imagination be not a repetition of animal movements, I aſk, in my turn, What is it? You tell me it conſiſts of images or pictures of things. Where is this extenſive canvas hung up? or where are the numerous receptacles in which thoſe are depoſited? or to what elſe in the animal ſyſtem have they any ſimilitude?

That

That pleaſing picture of objects, repreſented in miniature on the retina of the eye, ſeems to have given riſe to this illuſive oratory! It was forgot that this repreſentation belongs rather to the laws of light, than to thoſe of life; and may with equal elegance be ſeen in the camera obſcura as in the eye; and that the picture vaniſhes for ever, when the object is withdrawn.

SECT. IV.

LAWS OF ANIMAL CAUSATION.

I. The fibres, which conſtitute the muſcles and organs of ſenſe, poſſeſs a power of contraction. The circumſtances attending the exertion of this power of CONTRACTION conſtitute the laws of animal motion, as the circumſtances attending the exertion of the power of ATTRACTION conſtitute the laws of motion of inanimate matter.

II. The ſpirit of imagination is the immediate cauſe of the contraction of animal fibres, it reſides in the brain and nerves, and is liable to general or partial diminution or accumulation.

III. The ſtimulus of bodies external to the moving organ is the remote cauſe of the original contractions of animal fibres.

IV. A certain quantity of ſtimulus produces irritation, which is an exertion of the ſpirit of animation exciting the fibres into contraction.

V. A certain quantity of contraction of animal fibres, if it be perceived at all, produces pleaſure; a great-

a greater or leſs quantity of contraction, if it be perceived at all, produces pain; theſe conſtitute ſenſation.

VI. A certain quantity of ſenſation produces deſire or averſion; theſe conſtitute volition.

VII. All animal motions which have occurred at the ſame time, or in immediate ſucceſſion, become ſo connected, that when one of them is reproduced, the other has a tendency to accompany or ſucceed it. When fibrous contractions ſucceed or accompany other fibrous contractions, the connection is termed aſſociation; when fibrous contractions ſucceed ſenſorial motions, the connection is termed cauſation; when fibrous and ſenſorial motions reciprocally introduce each other, it is termed catenation of animal motions. All theſe connections are ſaid to be produced by habit, that is, by frequent repetition. Theſe laws of animal cauſation will be evinced by numerous facts, which occur in our daily exertions; and will afterwards be employed to explain the more recondite phænomena of the production, growth, diſcaſes, and decay of the animal ſyſtem.

SECT.

SECT. V.

OF THE FOUR FACULTIES OR MOTIONS OF THE SENSORIUM.

I. *Four ſenſorial powers.* 2. *Irritation, ſenſation, volition, aſſociation defined.* 3. *Senſorial motions diſtinguiſhed from fibrous motions.*

I. THE ſpirit of animation has four different modes of action, or in other words the animal ſenſorium poſſeſſes four different faculties, which are occaſionally exerted, and cauſe all the contractions of the fibrous parts of the body. Theſe are the faculty of cauſing fibrous contractions in conſequence of the irritations excited by external bodies, in conſequence of the ſenſations of pleaſure or pain, in conſequence of volition, and in conſequence of the aſſociations of fibrous contractions with other fibrous contractions, which precede or accompany them.

Theſe four faculties of the ſenſorium during their inactive ſtate are termed irritability, ſenſibility, voluntarity, and aſſociability; in their active ſtate they are termed as above, irritation, ſenſation, volition, aſſociation.

2. IRRITATION is an exertion or change of ſome extreme part of the ſenſorium reſiding in the muſcles or organs of ſenſe, in conſequence of the appulſes of external bodies.

SENSATION is an exertion or change of the central parts of the ſenſorium, or of the whole of it, *beginning* at ſome of thoſe extreme parts of it, which reſide in the muſcles or organs of ſenſe.

VOLITION

VOLITION is an exertion or change of the central parts of the ſenſorium, or the whole of it, *terminating* in ſome of thoſe extreme parts of it, which reſide in the muſcles or organs of ſenſe.

ASSOCIATION is an exertion or change of ſome extreme part of the ſenſorium reſiding in the muſcles or organs of ſenſe, in conſequence of ſome antecedent or attendant fibrous contractions.

3. Theſe four faculties of the animal ſenſorium may at the time of their exertions be termed motions without impropriety of language; for we cannot paſs from a ſtate of inſenſibility or inaction to a ſtate of ſenſibility or of exertion without ſome change of the ſenſorium, and every change includes motion. We ſhall therefore ſometimes term the above deſcribed faculties *ſenſorial motions* to diſtinguiſh them from *fibrous motions*; which latter expreſſion includes the motions of the muſcles and organs of ſenſe.

The active motions of the fibres, whether thoſe of the muſcles or organs of ſenſe, are probably ſimple contractions; the fibres being again elongated by antagoniſt muſcles, by circulating fluids, or ſometimes by elaſtic ligaments, as in the necks of quadrupeds. The ſenſorial motions, which conſtitute the ſenſations of pleaſure or pain, and which conſtitute the ſenſations of pleaſure or pain, and which conſtitute volition, and which cauſe the fibrous contractions in conſequence of irritation or of aſſociation, are not here ſuppoſed to be fluctuations or refluctuations of the ſpirit of animation; nor are they ſuppoſed to be vibrations or revibrations, nor condenſations or equilibrations of it; but to be changes or motions of it peculiar to life.

SECT.

SECT. VI.

OF THE FOUR CLASSES OF FIBROUS MOTIONS.

I. *Origin of fibrous contractions.* II. *Diſtribution of them into four claſſes, irritative motions, ſenſitive motions, voluntary motions, and aſſociate motions, defined.*

I. ALL the fibrous contractions of animal bodies originate from the ſenſorium, and reſolve themſelves into four claſſes, correſpondent with the four powers or motions of the ſenſorium above deſcribed, and from which they have their cauſation.

1. Theſe fibrous contractions were originally cauſed by the irritations excited by objects, which are external to the moving organ. As the pulſations of the heart are owing to the irritations excited by the ſtimulus of the blood; and the ideas of perception are owing to the irritations excited by external bodies.

2. But as painful or pleaſurable ſenſations frequently accompanied thoſe irritations, by habit theſe fibrous contractions became cauſable by the ſenſations, and the irritations ceaſed to be neceſſary to their production. As the ſecretion of tears in grief is cauſed by the ſenſation of pain; and the ideas of imagination, as in dreams or delirium, are excited by the pleaſure or pain, with which they were formerly accompanied.

3. But as the efforts of the will frequently accompanied theſe painful or pleaſurable ſenſations, by habit the fibrous contractions became cauſable by volition; and both the irritations and ſenſations ceaſed to be neceſſary to their production. As the deliberate

deliberate locomotions of the body, and the ideas of recollection, as when we will to repeat the alphabet backwards.

4. But as many of these fibrous contractions frequently accompanied other fibrous contractions, by habit they became causable by their associations with them; and the irritations, sensations, and volition, ceased to be necessary to their production. As the actions of the muscles of the lower limbs in fencing are associated with those of the arms; and the ideas of suggestion are associated with other ideas, which precede or accompany them; as in repeating carelessly the alphabet in its usual order after having began it.

II. We shall give the following names to these four classes of fibrous motions, and subjoin their definitions.

1. Irritative motions. That exertion or change of the sensorium, which is caused by the appulses of external bodies, either simply subsides, or is succeeded by sensation, or it produces fibrous motions; it is termed irritation, and irritative motions are those contractions of the muscular fibres, or of the organs of sense, that are immediately consequent to this exertion or change of the sensorium.

2. Sensitive motions. That exertion or change of the sensorium, which constitutes pleasure or pain, either simply subsides, or is succeeded by volition, or it produces fibrous motions; it is termed sensation, and the sensitive motions are those contractions of the muscular fibres, or of the organs of sense, that are immediately consequent to this exertion or change of the sensorium.

3. Voluntary motions. That exertion or change of the sensorium, which constitutes desire or aversion, either simply subsides, or is succeeded by fibrous motions; it is then termed volition, and voluntary

luntary motions are thoſe contractions of the muſcular fibres, or of the organs of ſenſe, that are immediately conſequent to this exertion or change of the ſenſorium.

4. Aſſociate motions. That exertion or change of the ſenſorium, which accompanies fibrous motions, either ſimply ſubſides, or is ſucceeded by ſenſation or volition, or it produces other fibrous motions; it is then termed aſſociation, and the aſſociate motions are thoſe contractions of the muſcular fibres, or of the organs of ſenſe, that are immediately conſequent to this exertion or change of the ſenſorium.

SECT. VII.

OF IRRITATIVE MOTIONS.

I. 1. *Some muſcular motions are excited by perpetual irritations.* 2. *Others more frequently by ſenſations.* 3. *Others by volition. Caſe of involuntary ſtretchings in paralytic limbs.* 4. *Some ſenſual motions are excited by perpetual irritations.* 5. *Others more frequently by ſenſation or volition.*

II. 1. *Muſcular motions excited by perpetual irritations occaſionally become obedient to ſenſation and to volition.* 2. *And the ſenſual motions.*

III. 1. *Other muſcular motions are aſſociated with the irritative ones.* 2. *And other ideas with irritative ones. Of letters, language, hieroglyphics. Irritative ideas exiſt without our attention to them.*

I. 1. MANY of our muſcular motions are excited by perpetual irritations, as thoſe of the heart and

and arterial ſyſtem by the circumfluent blood. Many other of them are excited by intermitted irritations, as thoſe of the ſtomach and bowels by the aliment we ſwallow; of the bile-ducts by the bile; of the kidneys, pancreas, and many other glands, by the peculiar fluids they ſeparate from the blood; and thoſe of the lacteal and other ſubſequent veſſels by the chyle, lymph, and moiſture of the atmoſphere. Theſe motions are accelerated or retarded, as their correſpondent irritations are increaſed or diminiſhed, without our attention or conſciouſneſs, in the ſame manner as the various ſecretions of fruit, gum, reſin, wax, and honey, are produced in the vegetable world, and as the juices of the earth and the moiſture of the atmoſphere are abſorbed by their roots and foliage.

2. Other muſcular motions, that are moſt frequently connected with our ſenſations, are thoſe of the ſphincters of the bladder and anus, and the muſculi erectores penis, were originally excited into motion by irritation, for young children make water, and have other evacuations without attention to theſe circumſtances; "et primis etiam ab incunabulis tenduntur ſæpius puerorum penes, amore nondum expergefacto." So the nipples of young women are liable to become turgid by irritation, long before they are in a ſituation to be excited by the pleaſure of giving milk to the lips of a child.

3. The contractions of the larger muſcles of our bodies, that are moſt frequently connected with volition, were originally excited into action by internal irritations: as appears from the ſtretching or yawning of all animals after long ſleep. In the beginning of ſome fevers this irritation of the muſcles produces perpetual ſtretching and yawning; in other periods of fever an univerſal reſtleſſneſs ariſes from the ſame cauſe, the patient changing the attitude of his body every minute. The repeated

ſtruggles

ſtruggles of the fœtus in the uterus muſt be owing to this internal irritation: for the fœtus can have no other inducement to move its limbs but the tædium or irkſomeneſs of a continued poſture.

The following caſe evinces, that the motions of ſtretching the limbs after a continued attitude are not always owing to the power of the will. Mr. Dean, a maſon, of Auſtry in Leiceſterſhire, had the ſpine of the third vertebra of the back enlarged; in ſome weeks his lower extremities became feeble, and at length quite paralytic: neither the pain of bliſters, the heat of fomentations, nor the utmoſt efforts of the will could produce the leaſt motion in theſe limbs; yet twice or thrice a day for many months his feet, legs, and thighs, were affected for many minutes with forcible ſtretchings, attended with the ſenſation of fatigue; and he at length recovered the uſe of his limbs, though the ſpine continued protuberant. The ſame circumſtance is frequently ſeen in a leſs degree in the common hemiplagia; and when this happens, I have believed repeated and ſtrong ſhocks of electricity to have been of great advantage.

4. In like manner the various organs of ſenſe are originally excited into motion by various external ſtimuli adapted to this purpoſe, which motions are termed perceptions or ideas; and many of theſe motions during our waking hours are excited by perpetual irritation, as thoſe of the organs of hearing and of touch. The former by the conſtant low indiſtinct noiſes that murmur around us, and the latter by the weight of our bodies on the parts which ſupport them; and by the unceaſing variations of the heat, moiſture, and preſſure of the atmoſphere; and theſe ſenſual motions, preciſely as the muſcular ones above mentioned, obey their correſpondent irritations without our attention or conſciouſneſs.

5. Other

5. Other claſſes of our ideas are more frequently excited by our ſenſations of pleaſure or pain, and others by volition: but that theſe have all been originally excited by ſtimuli from external objects, and only vary in their combinations or ſeparations, has been fully evinced by Mr. Locke: and are by him termed the ideas of perception in contradiſtinction to thoſe, which he calls the ideas of reflection.

II. 1. Theſe muſcular motions, that are excited by perpetual irritation, are nevertheleſs occaſionally excitable by the ſenſations of pleaſure or pain, or by volition; as appears by the palpitation of the heart from fear, the increaſed ſecretion of ſaliva at the ſight of agreeable food, and the glow on the ſkin of thoſe who are aſhamed. There is an inſtance told in the Philoſophical Tranſactions of a man, who could for a time ſtop the motion of his heart when he pleaſed; and Mr. D. has often told me, he could ſo far increaſe the periſtaltic motion of his bowels by voluntary efforts, as to produce an evacuation by ſtool at any time in half an hour.

2. In like manner the ſenſual motions, or ideas, that are excited by perpetual irritation, are nevertheleſs occaſionally excited by ſenſation or volition; as in the night, when we liſten under the influence of fear, or from voluntary attention, the motions excited in the organ of hearing by the whiſpering of the air in our room, the pulſation of our own arteries, or the faint beating of a diſtant watch, become objects of perception.

III. Innumerable trains or tribes of other motions are aſſociated with theſe muſcular motions which are excited by irritation; as by the ſtimulus of the blood in the right chamber of the heart, the lungs are induced to expand themſelves; and the pectoral and intercoſtal muſcles, and the diaphragm, act at the ſame time by their aſſociations with them.

And

And when the pharynx is irritated by agreeable food, the muſcles of deglutition are brought into action by aſſociation. Thus when a greater light falls on the eye, the iris is brought into action without our attention; and the ciliary proceſs, when the focus is formed before or behind the retina, by their aſſociations with the increaſed irritative motions of the organ of viſion. Many common actions of life are produced in a ſimilar manner. If a fly ſettle on my forehead, whilſt I am intent on my preſent occupation, I diſlodge it with my finger, without exciting my attention or breaking the train of my ideas.

2. In like manner the irritative ideas ſuggeſt to us many other trains or tribes of ideas that are aſſociated with them. On this kind of connection, language, letters, hieroglyphics, and every kind of ſymbol, depend. The ſymbols themſelves produce irritative ideas, or ſenſual motions, which we do not attend to; and other ideas, that are ſucceeded by ſenſation, are excited by their aſſociation with them. And as theſe irritative ideas make up a part of the chain of our waking thoughts, introducing other ideas that engage our attention, though themſelves are unattended to, we find it very difficult to inveſtigate by what ſteps many of our hourly trains of ideas gain their admittance.

It may appear paradoxical, that ideas can exiſt, and not be attended to; but all our perceptions are ideas excited by irritation, and ſucceeded by ſenſation. Now when theſe ideas excited by irritation give us neither pleaſure nor pain, we ceaſe to attend to them. Thus whilſt I am walking through that grove before my window, I do not run againſt the trees or the benches, though my thoughts are ſtrenuouſly exerted on ſome other object. This leads us to a diſtinct knowledge of irritative ideas, for the idea of the tree or bench, which I avoid, exiſts on

my

my retina, and induces by aſſociation the action of certain locomotive muſcles; though neither itſelf nor the actions of thoſe muſcles engage my attention.

Thus whilſt we are converſing on this ſubject, the tone, note, and articulation of every individual word forms its correſpondent irritative idea on the organ of hearing; but we only attend to the aſſociated ideas, that are attached by habit to theſe irritative ones, and are ſucceeded by ſenſation; thus when we read the words "PRINTING-PRESS" we do not attend to the ſhape, ſize, or exiſtence of the letters which compoſe theſe words, though each of them excites a correſpondent irritative motion of our organ of viſion, but they introduce by aſſociation our idea of the moſt uſeful of modern inventions; the capacious reſervoir of human knowledge, whoſe branching ſtreams diffuſe ſciences, arts, and morality, through all nations and all ages.

SECT. VIII.

OF SENSITIVE MOTIONS.

I. 1. *Senſitive muſcular motions were originally excited into action by irritation.* 2. *And ſenſitive ſenſual motions, ideas of imagination, dreams.* II. 1. *Senſitive muſcular motions are occaſionally obedient to volition.* 2. *And ſenſitive ſenſual motions.* III. 1. *Other muſcular motions are aſſociated with the ſenſitive ones.* 2. *And other ſenſual motions.*

I. 1. MANY of the motions of our muſcles, that are excited into action by irritation, are at

the ſame time accompanied with painful or pleaſurable ſenſations; and at length become by habit cauſable by the ſenſations. Thus the motions of the ſphincters of the bladder and anus were originally excited into action by irritation; for young children give no attention to theſe evacuations; but as ſoon as they become ſenſible of the inconvenience of obeying theſe irritations, they ſuffer the water or excrement to accumulate, till it diſagreeably affects them; and the action of thoſe ſphincters is then in conſequence of this diſagreeable ſenſation. So the ſecretion of ſaliva, which in young children is copiouſly produced by irritation, and drops from their mouths, is frequently attended with the agreeable ſenſation produced by the maſtication of taſteful food; till at length the ſight of ſuch food to a hungry perſon excites into action theſe ſalival glands; as is ſeen in the ſlavering of hungry dogs.

The motions of thoſe muſcles, which are affected by laſcivious ideas, and thoſe which are exerted in ſmiling, weeping, ſtarting from fear, and winking at the approach of danger to the eye, and at times the actions of every large muſcle of the body become cauſable by our ſenſations. And all theſe motions are performed with ſtrength and velocity in proportion to the energy of the ſenſation that excites them, and the quantity of ſenſorialower.

2. Many of the motions of our organs of ſenſe, or ideas, that were originally excited into action by irritation, become in like manner more frequently cauſable by our ſenſations of pleaſure or pain. Theſe motions are then termed the ideas of imagination, and make up all the ſcenery and tranſactions of our dreams. Thus when any painful or pleaſurable ſenſations poſſeſs us, as of love, anger, fear; whether in our ſleep or waking hours, the ideas, that have been

been formerly excited by the objects of theſe ſenſations, now vividly recur before us by their connection with theſe ſenſations themſelves. So the fair ſmiling virgin, that excited your love by her preſence, whenever that ſenſation recurs, riſes before you in imagination; and that with all the pleaſing circumſtances, that had before engaged your attention. And in ſleep, when you dream under the influence of fear, all the robbers, fires, and precipices, that you formerly have ſeen or heard of, ariſe before you with terrible vivacity. All theſe ſenſual motions, like the muſcular ones above mentioned, are performed with ſtrength and velocity in proportion to the energy of the ſenſation of pleaſure or pain, which excites them, and the quantity of ſenſorial power.

III. 1. Many of theſe muſcular motions above deſcribed, that are moſt frequently excited by our ſenſations, are nevertheleſs occaſionally cauſable by volition; for we can ſmile or frown ſpontaneouſly, can make water before the quantity or acrimony of the urine produces a diſagreeable ſenſation, and can voluntarily maſticate a nauſeous drug, or ſwallow a bitter draught, though our ſenſation would ſtrongly diſſuade us.

2. In like manner the ſenſual motions, or ideas, that are moſt frequently excited by our ſenſations, are nevertheleſs occaſionally cauſeable by volition, as we can ſpontaneouſly call up laſt night's dream before us, tracing it induſtriouſly ſtep by ſtep through all its variety of ſcenery and tranſaction; or can voluntarily examine or repeat the ideas, that have been excited by our diſguſt or admiration.

III. 1. Innumerable trains or tribes of motions are aſſociated with theſe ſenſitive muſcular motions above mentioned; as when a drop of water falling into the wind-pipe diſagreeably affects the air-veſſels of the lungs, they are excited into violent action;

and with theſe ſenſitive motions are aſſociated the actions of the pectoral and intercoſtal muſcles, and the diaphragm; till by their united and repeated ſucceſſions the drop is returned through the larynx. The ſame occurs when any thing diſagreeably affects the noſtrils, or the ſtomach, or the uterus; variety of muſcles are excited by aſſociation into forcible action, not to be ſuppreſſed by the utmoſt efforts of the will; as in ſneezing, vomiting, and parturition.

2. In like manner with theſe ſenſitive ſenſual motions, or ideas of imagination, are aſſociated many other trains or tribes of ideas, which by ſome writers of metaphyſics have been claſſed under the terms of reſemblance, cauſation, and contiguity; and will be more fully treated of hereafter.

SECT. IX.

OF VOLUNTARY MOTIONS.

I. 1. *Voluntary muſcular motions are originally excited by irritations.* 2. *And voluntary ideas. Of reaſon.* II. 1. *Voluntary muſcular motions are occaſionally cauſable by ſenſations.* 2. *And voluntary ideas.* III. 1. *Voluntary muſcular motions are occaſionally obedient to irritations.* 2. *And voluntary ideas.* IV. 1. *Voluntary muſcular motions are aſſociated with other muſcular motions.* 2. *And voluntary ideas.*

WHEN pleaſure or pain affect the animal ſyſtem, many of its motions both muſcular and ſenſual are brought

brought into action; as was ſhewn in the preceding ſection, and were called ſenſitive motions. The general tendency of theſe motions is to arreſt and to poſſeſs the pleaſure, or to diſlodge or avoid the pain: but if this cannot immediately be accompliſhed, deſire or averſion are produced, and the motions in conſequence of this new faculty of the ſenſorium are called voluntary.

I. 1. Thoſe muſcles of the body that are attached to bones, have in general their principal connections with volition, as I move my pen or raiſe my body. Theſe motions were originally excited by irritation, as was explained in the ſection on that ſubject, afterwards the ſenſations of pleaſure or pain, that accompanied the motions thus excited, induced a repetition of them; and at length many of them were voluntarily practiſed in ſucceſſion or in combination for the common purpoſes of life, as in learning to walk, or to ſpeak; and are performed with ſtrength and velocity in proportion to the energy of the volition, that excites them, and the quantity of ſenſorial power.

2. Another great claſs of voluntary motions conſiſts of the ideas of recollection. We will to repeat a certain train of ideas, as of the alphabet backwards; and if any ideas, that do not belong to this intended train, intrude themſelves by other connections, we will to reject them, and voluntarily perſiſt in the determined train. So at my approach to a houſe which I have but once viſited, and that at the diſtance of many months, I will to recollect the names of the numerous family I expect to ſee there, and I do recollect them.

On this voluntary recollection of ideas our faculty of reaſon depends, as it enables us to acquire an idea of the diſſimilitude of any two ideas. Thus if you voluntarily produce the idea of a right-angled triangle, and then of a ſquare; and after having excited

excited theſe ideas repeatedly, you excite the idea of their difference, which is that of another right-angled triangle inverted over the former; you are ſaid to reaſon upon this ſubject, or to compare your ideas.

Theſe ideas of recollection, like the muſcular motions above mentioned, were originally excited by the irritation of external bodies, and were termed ideas of perception: afterwards the pleaſure or pain, that accompanied theſe motions, induced a repetition of them in the abſence of the external body, by which they were firſt excited; and then they were termed ideas of imagination. At length they become voluntarily practiſed in ſucceſſion or in combination for the common purpoſes of life; as when we make ourſelves maſters of the hiſtory of mankind, or of the ſciences they have inveſtigated; and are then called ideas of recollection; and are performed with ſtrength and velocity in proportion to the energy of the volition that excites them, and the quantity of ſenſorial power.

II. 1. The muſcular motions above deſcribed, that are moſt frequently obedient to the will, are nevertheleſs occaſionally cauſable by painful or pleaſurable ſenſation, as in the ſtarting from fear, and the contraction of the calf of the leg in the cramp.

2. In like manner the ſenſual motions, or ideas, that are moſt frequently connected with volition, are nevertheleſs occaſionally cauſable by painful or pleaſurable ſenſation. As the hiſtories of men, or the deſcription of places, which we have voluntarily taken pains to remember, ſometimes occur to us in our dreams.

III. 1. The muſcular motions that are generally ſubſervient to volition, are alſo occaſionally cauſable by irritation, as in ſtretching the limbs after ſleep, and yawning. In this manner a contraction of the arm is produced by paſſing the electric fluid from

from the Leyden phial along its muſcles; and that even though the limb is paralytic. The ſudden motion of the arm produces a diſagreeable ſenſation in the joint, but the muſcles ſeem to be brought into action ſimply by irritation.

2. The ideas, that are generally ſubſervient to the will, are in like manner occaſionally excited by irritation; as when we view again an object, we have before well ſtudied, and often recollected.

IV. 1. Innumerable trains or tribes of motions are aſſociated with theſe voluntary muſcular motions above mentioned; as when I will to extend my arm to a diſtant object, ſome other muſcles are brought into action, and preſerve the balance of my body. And when I wiſh to perform any ſteady exertion, as in threading a needle, or chopping with an ax, the pectoral muſcles are at the ſame time brought into action to preſerve the trunk of the body motionleſs, and we ceaſe to reſpire for a time.

2. In like manner the voluntary ſenſual motions, or ideas of recollection, are aſſociated with many other trains or tribes of ideas. As when I voluntarily recollect a gothic window, that I ſaw ſome time ago, the whole front of the cathedral occurs to me at the ſame time.

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SECT. X.

OF ASSOCIATE MOTIONS.

I, 1. *Many muſcular motions excited by irritations in trains or tribes become aſſociated.* 2. *And many ideas.* II. 1. *Many ſenſitive muſcular motions become aſſociated.* 2. *And many ſenſitive ideas.* III. 1. *Many voluntary muſcular motions become aſſociated.* 2. *And then become obedient to ſenſation or irritation.* 3. *And many voluntary ideas become aſſociated.*

ALL the fibrous motions, whether muſcular or ſenſual, which are frequently brought into action together, either in combined tribes, or in ſucceſſive trains, become ſo connected by habit, that when one of them is reproduced the others have a tendency to ſucceed or accompany it.

I. 1. Many of our muſcular motions were originally excited in ſucceſſive trains, as the contractions of the auricles and of the ventricles of the heart; and others in combined tribes, as the various diviſions of the muſcles which compoſe the calf of the leg, which were originally irritated into ſynchronous action by the tædium or irkſomeneſs of a continued poſture. By frequent repetitions theſe motions acquire aſſociations, which continue during our lives, and even after the deſtruction of the greateſt part of the ſenſorium; for the heart of a viper or frog will continue to pulſate long after it is taken from the body; and when it has entirely ceaſed to move, if any part of it is goaded with a pin, the whole heart will again renew its pulſations. This kind of connection we ſhall term irritative aſſociation, to diſtinguiſh it from ſenſitive and voluntary aſſociations.

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2. In like manner many of our ideas are originally excited in tribes; as all the objects of ſight, after we become ſo well acquainted with the laws of viſion, as to diſtinguiſh figure and diſtance as well as colour; or in trains, as while we paſs along the objects that ſurround us. The tribes thus received by irritation become aſſociated by habit, and have been termed complex ideas by the writers of metaphyſics, as this book or that orange. The trains have received no particular name, but theſe are alike aſſociations of ideas, and frequently continue during our lives. So the taſte of a pine-apple, though we eat it blindfold, recalls the colour and ſhape of it; and we can ſcarcely think on ſolidity without figure.

II. 1. By the various efforts of our ſenſations to acquire or avoid their objects, many muſcles are daily brought into ſucceſſive or ſynchronous actions; theſe become aſſociated by habit, and are then excited together with great facility, and in many inſtances gain indiſſoluble connections. So the play of puppies and kittens is a repreſentation of their mode of fighting or of taking their prey; and the motions of the muſcles neceſſary for thoſe purpoſes become aſſociated by habit, and gain a great adroitneſs of action by theſe early repetitions: ſo the motions of the abdominal muſcles, which were originally brought into concurrent action with the protruſive motion of the rectum or bladder by ſenſation, become ſo conjoined with them by habit, that they not only eaſily obey theſe ſenſations occaſioned by the ſtimulus of the excrement and urine, but are brought into violent and unreſtrainable action in the ſtrangury and teneſmus. This kind of connection we ſhall term ſenſitive aſſociation.

2. So many of our ideas, that have been excited together or in ſucceſſion by our ſenſations, gain ſynchronous or ſucceſſive aſſociations, that are ſometimes

times indiſſoluble but with life. Hence the idea of an inhuman or diſhonourable action perpetually calls up before us the idea of the wretch that was guilty of it. And hence thoſe unconquerable antipathies are formed, which ſome people have to the ſight of peculiar kinds of food, of which in their infancy they have eaten to exceſs or by conſtraint.

III. 1. In learning any mechanic art, as muſic, dancing, or the uſe of the ſword, we teach many of our muſcles to act together or in ſucceſſion by repeated voluntary efforts; which by habit become formed into tribes or trains of aſſociation, and ſerve all our purpoſes with great facility, and in ſome inſtances acquire an indiſſoluble union. Theſe motions are gradually formed into a habit of acting together by a multitude of repetitions, whilſt they are yet ſeparately cauſable by the will, as is evident from the long time that is taken up by children in learning to walk and to ſpeak; and is experienced by every one, when he firſt attempts to ſkate upon the ice or to ſwim; theſe we ſhall term voluntary aſſociations.

2. All theſe muſcular movements, when they are thus aſſociated into tribes or trains, become afterwards not only obedient to volition, but to the ſenſations and irritations; and the ſame movement compoſes a part of many different tribes or trains of motions. Thus a ſingle muſcle, when it acts in conſort with its neighbours on one ſide, aſſiſts to move the limb in one direction; and in another, when it acts with thoſe in its neighbourhood on the other ſide; and in other directions, when it acts ſeparately or jointly with thoſe that lie immediately under or above it; and all theſe with equal facility after their aſſociations have been well eſtabliſhed.

The facility, with which each muſcle changes from one aſſociated tribe to another, and that either backwards or forwards, is well obſervable

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in the muſcles of the arm in moving the windlaſs of an air-pump; and the ſlowneſs of thoſe muſcular movements, that have not been aſſociated by habit, may be experienced by any one, who ſhall attempt to ſaw the air quick perpendicularly with one hand, and horizontally with the other at the ſame time.

3. In learning every kind of ſcience we voluntarily aſſociate many tribes and trains of ideas, which afterwards are ready for all the purpoſes either of volition, ſenſation, or irritation; and in ſome inſtances acquire indiſſoluble habits of acting together, ſo as to affect our reaſoning, and influence our actions. Hence the neceſſity of a good education.

Theſe aſſociate ideas are gradually formed into habits of acting together by frequent repetition, while they are yet ſeparately obedient to the will; as is evident from the difficulty we experience in gaining ſo exact an idea of the front of St. Paul's church, as to be able to delineate it with accuracy, or in recollecting a poem of a few pages.

And theſe ideas, thus aſſociated into tribes, not only make up the parts of the trains of volition, ſenſation, and irritation; but the ſame idea compoſes a part of many different tribes and trains of ideas. So the ſimple idea of whiteneſs compoſes a part of the complex idea of ſnow, milk, ivory; and the complex idea of the letter A compoſes a part of the ſeveral aſſociated trains of ideas that make up the variety of words, in which this letter enters.

The numerous trains of theſe aſſociated ideas are divided by Mr. Hume into three claſſes, which he has termed contiguity, cauſation, and reſemblance. Nor ſhould we wonder to find them thus connected together, ſince it is the buſineſs of our lives to diſpoſe them into theſe three claſſes; and we become valuable to ourſelves and our friends, as we ſucceed

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in it. Thoſe who have combined an extenſive claſs of ideas by the contiguity of time or place, are men learned in the hiſtory of mankind, and of the ſciences they have cultivated. Thoſe who have connected a great claſs of ideas of reſemblances, poſſeſs the ſource of the ornaments of poetry and oratory, and of all rational analogy. While thoſe who have connected great claſſes of ideas of cauſation, are furniſhed with the powers of producing effects. Theſe are the men of active wiſdom. who lead armies to victory, and kingdoms to proſperity; or diſcover and improve the ſciences, which meliorate and adorn the condition of humanity.

SECT. XI.

ADDITIONAL OBSERVATIONS ON THE SENSORIAL POWERS.

I. *Stimulation is of various kinds adapted to the organs of ſenſe, to the muſcles, to hollow membranes, and glands. Some objects irritate our ſenſes by repeated impulſes.* II. 1. *Senſation and volition frequently affect the whole ſenſorium.* 2. *Emotions, paſſions, appetites.* 3. *Origin of deſire and averſion. Criterion of voluntary actions, difference of brutes and men.* 4. *Senſibility and voluntarity.* III. *Aſſociations formed before nativity, irritative motions miſtaken for aſſociated ones.*

Irritation.

I. THE various organs of ſenſe require various kinds of ſtimulation to excite them into action; the

the particles of light penetrate the cornea and humours of the eye, and then irritate the naked retina; ſapid particles, diſſolved or diffuſed in water or ſaliva, and odorous ones, mixed or combined with the air, irritate the extremities of the nerves of taſte and ſmell; which either penetrate, or are expanded on the membranes of the tongue and noſtrils; the auditory nerves are ſtimulated by the vibrations of the atmoſphere communicated by means of the tympanum and of the fluid, whether of air or of water, behind it; and the nerves of touch by the hardneſs of ſurrounding bodies, though the cuticle is interpoſed between theſe bodies and the medulla of the nerve.

As the nerves of the ſenſes have each their appropriated objects, which ſtimulate them into activity; ſo the muſcular fibres, which are the terminations of other ſets of nerves, have their peculiar objects, which excite them into action; the longitudinal muſcles are ſtimulated into contraction by extenſion, whence the ſtretching or pandiculation after a long continued poſture, during which they have been kept in a ſtate of extenſion; and the hollow muſcles are excited into action by diſtention, as thoſe of the rectum and bladder are induced to protrude their contents from their ſenſe of the diſtention rather than of the acrimony of thoſe contents.

There are other objects adapted to ſtimulate the nerves, which terminate in a variety of membranes, and thoſe eſpecially which form the terminations of canals; thus the preparations of mercury particularly affect the ſalivary glands, ipecacuanha the ſtomach, aloe the ſphincter of the anus, cantharides that of the bladder, and laſtly every gland of the body appears to be indued with a kind of taſte, by which it ſelects or forms each its peculiar fluid from the blood; and by which it is irritated into activity.

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Many of theſe external properties of bodies, which ſtimulate our organs of ſenſe, do not ſeem to effect this by a ſingle impulſe, but by repeated impulſes; as the nerve of the ear is probably not excitable by a ſingle vibration of air, nor the optic nerve by a ſingle particle of light; which circumſtance produces ſome analogy between thoſe two ſenſes, at the ſame time the ſolidity of bodies is perceived by a ſingle application of a ſolid body to the nerves of touch, and that even through the cuticle; and we are probably poſſeſſed of a peculiar ſenſe to diſtinguiſh the nice degrees of heat and cold.

The ſenſes of touch and of hearing acquaint us with the mechanical impact and vibration of bodies, thoſe of ſmell and taſte ſeem to acquaint us with ſome of their chemical properties, while the ſenſe of viſion and of heat acquaint us with the exiſtence of their peculiar fluids.

Senſation and Volition.

II. Many motions are produced by pleaſure or pain, and that even in contradiction to the power of volition, as in laughing, or in the ſtrangury; but as no name has been given to pleaſure or pain, at the time it is exerted ſo as to cauſe fibrous motions, we have uſed the term ſenſation for this purpoſe; and mean it to bear the ſame analogy to pleaſure and pain, that the word volition does to deſire and averſion.

1. It was mentioned in the fifth Section, that, what we have termed ſenſation is a motion of the central parts, or of the whole ſenſorium, *beginning* at ſome extremities of it. This appears firſt, becauſe our pains and pleaſures are always cauſed by our ideas or muſcular motions, which are the motions of the extremities of the ſenſorium. And, ſecondly, becauſe the ſenſation of pleaſure or pain frequently

frequently continues ſome time after the ideas or muſcular motions which excited it have ceaſed: for we often feel a glow of pleaſure from an agreeable reverie, for many minutes after the ideas, that were the ſubject of it, have eſcaped our memory; and frequently experience a dejection of ſpirits without being able to aſſign the cauſe of it but by much recollection.

When the ſenſorial faculty of deſire or averſion is exerted ſo as to cauſe fibrous motions, it is termed volition; which is ſaid in Sect. V. to be a motion of the central parts, or of the whole ſenſorium, *terminating* in ſome of the extremities of it. This appears, firſt, becauſe our deſires and averſions always terminate in recollecting and comparing our ideas, or in exerting our muſcles; which are the motions of the extremities of the ſenſorium And, ſecondly, becauſe deſire or averſion begins, and frequently continues for a time in the central parts of the ſenſorium, before it is peculiarly exerted at the extremities of it; for we ſometimes feel deſire or averſion without immediately knowing their objects, and in conſequence without immediately exerting any of our muſcular or ſenſual motions to attain them: as in the beginning of the paſſion of love, and perhaps of hunger, or in the ennui of indolent people.

Though ſenſation and volition begin or terminate at the extremities or central parts of the ſenſorium, yet the whole of it is frequently influenced by the exertion of theſe faculties, as appears from their effects on the external habit: for the whole ſkin is reddened by ſhame, and an univeral trembling is produced by fear: and every muſcle of the body is agitated in angry people by the deſire of revenge.

There is another ver ycurious circumſtance, which ſhews that ſenſation and volition are movements of the

the ſenſorium in contrary directions; that is, that volition begins at the central parts of it, and proceeds to the extremities; and that ſenſation begins at the extremities, and proceeds to the central parts: I mean that theſe two ſenſorial faculties cannot be ſtrongly exerted at the ſame time; for when we exert our volition ſtrongly, we do not attend to pleaſure or pain; and converſely, when we are ſtrongly affected with the ſenſation of pleaſure or pain, we uſe no volition. As will be further explained in Section XVIII. on ſleep, and Section XXXIV. on volition.

2. All our emotions and paſſions ſeem to ariſe out of the exertions of theſe two faculties of the animal ſenſorium. Pride, hope, joy, are the names of particular pleaſures: ſhame, deſpair, ſorrow, are the names of peculiar pains: and love, ambition, avarice, of particular deſires: hatred, diſguſt, fear, anxiety, of particular averſions. Whilſt the paſſion of anger includes the pain from a recent injury, and the averſion to the adverſary that occaſioned it. And compaſſion is the pain we experience at the ſight of miſery, and the deſire of relieving it.

There is another tribe of deſires, which are commonly termed appetites, and are the immediate conſequences of the abſence of ſome irritative motions. Thoſe, which ariſe from defect of internal irritations, have proper names conferred upon them, as hunger, thirſt, luſt, and the deſire of air, when our reſpiration is impaired by noxious vapours; and of warmth, when we are expoſed to too great a degree of cold. But thoſe, whoſe ſtimuli are external to the body, are named from the objects, which are by nature conſtituted to excite them; theſe deſires originate from our paſt experience of the pleaſurable ſenſations they occaſion,

as

as the ſmell of an hyacinth, or the taſte of a pine-apple.

Whence it appears, that our pleaſures and pains are at leaſt as various and as numerous as our irritations; and that our deſires and averſions muſt be as numerous as our pleaſures and pains. And that as ſenſation is here uſed as a general term for our numerous pleaſures and pains, when they produce the contractions of our fibres; ſo volition is the general name for our deſires and averſions, when they produce fibrous contractions. Thus when a motion of the central parts, or of the whole ſenſorium, terminates in the exertion of our muſcles, it is generally called voluntary action; when it terminates in the exertion of our ideas, it is termed recollection, reaſoning, determining.

3. As the ſenſations of pleaſure and pain are originally introduced by the irritations of external objects: ſo our deſires and averſions are originally introduced by thoſe ſenſations; for when the objects of our pleaſures or pains are at a diſtance, and we cannot inſtantaneouſly poſſeſs the one, or avoid the other, then deſire or averſion is produced, and a voluntary exertion of our ideas or muſcles ſucceeds.

The pain of hunger excites you to look out for food, the tree, that ſhades you, preſents its odoriferous fruit before your eyes, you approach, pluck, and eat.

The various movements of walking to the tree, gathering the fruit, and maſticating it, are aſſociated motions introduced by their connection with ſenſation; but if from the uncommon height of the tree, the fruit be inacceſſible, and you are prevented from quickly poſſeſſing the intended pleaſure, deſire is produced. The conſequence of this deſire is, firſt, a deliberation about the means to gain the object of pleaſure in proceſs of time, as it cannot

be procured immediately; and, ſecondly, the muſcular action neceſſary for this purpoſe.

You voluntarily call up all your ideas of cauſation, that are related to the effect you deſire, and voluntarily examine and compare them, and at length determine whether to aſcend the tree, or to gather ſtones from the neighbouring brook, is eaſier to practiſe, or more promiſing of ſucceſs; and, finally, you gather the ſtones, and repeatedly fling them to diſlodge the fruit.

Hence then we gain a criterion to diſtinguiſh voluntary acts or thoughts from thoſe cauſed by ſenſation. As the former are always employed about the *means* to acquire pleaſurable objects, or the *means* to avoid painful ones; while the latter are employed in the poſſeſſion of thoſe, which are already in our power.

Hence the activity of this power of volition produces the great difference between the human and the brute creation. The ideas and the actions of brutes are almoſt perpetually employed about their preſent pleaſures, or their preſent pains; and, except in the few inſtances which are mentioned in Section XVI. on inſtinct, they ſeldom buſy themſelves about the means of procuring future bliſs, or of avoiding future miſery; ſo that the acquiring of languages, the making of tools, and labouring for money, which are all only the means to procure pleaſures; and the praying to the Deity, as another means to procure happineſs, are characteriſtic of human nature.

4. As there are many diſeaſes produced by the quantity of the ſenſation of pain or pleaſure being too great or too little; ſo are there diſeaſes produced by the ſuſceptibility of the conſtitution to motions cauſable by theſe ſenſations being too dull or too vivid. This ſuſceptibility of the ſyſtem to ſenſitive motions is termed ſenſibility, to diſtinguiſh it from

from ſenſation, which is the actual exiſtence or exertion of pain or pleaſure.

Other claſſes of diſeaſes are owing to the exceſſive promptitude, or ſluggiſhneſs of the conſtitution to voluntary exertions, as well as to the quantity of deſire or of averſion. This ſuſceptibility of the ſyſtem to voluntary motions is termed voluntarity, to diſtinguiſh it from volition, which is the exertion of deſire or averſion; theſe diſeaſes will be treated of at length in the progreſs of the work.

Aſſociation.

III. 1. It is not eaſy to aſſign a cauſe, why thoſe animal movements, that have once occurred in ſucceſſion, or in combination, ſhould afterwards have a tendency to ſucceed or accompany each other. It is a property of animation, and diſtinguiſhes this order of being from the other productions of nature.

When a child firſt wrote the word man, it was diſtinguiſhed in his mind into three letters, and thoſe letters into many parts of letters; but by repeated uſe the word man becomes to his hand in writing it, as to his organs of ſpeech in pronouncing it, but one movement without any deliberation, or ſenſation, or irritation, interpoſed between the parts of it. And as many ſeparate motions of our muſcles thus become united, and form, as it were, one motion; ſo each ſeparate motion before ſuch union may be conceived to conſiſt of many parts or ſpaces moved through; and perhaps even the individual fibres of our muſcles have thus gradually been brought to act in concert, which habits began to be acquired as early as the very formation of the moving organs, long before the nativity of the animal; as explained in the Section XVI. 2. on inſtinct.

2. There are many motions of the body, belonging to the irritative claſs, which might by a haſty obſerver be miſtaken for aſſociated ones; as the periſtaltic motion of the ſtomach and inteſtines, and the contractions of the heart and arteries, might be ſuppoſed to be aſſociated with the irritative motions of their nerves of ſenſe, rather than to be excited by the irritation of their muſcular fibres by the diſtention, acrimony, or momentum of the blood. So the diſtention or elongation of muſcles by objects external to them irritates them into contraction, though the cuticle or other parts may intervene between the ſtimulating body and the contracting muſcle. Thus a horſe voids his excrement when its weight or bulk irritates the rectum or ſphincter ani. Theſe muſcles act from the irritation of diſtention, when he excludes his excrement, but the muſcles of the abdomen and diaphragm are brought into motion by aſſociation with thoſe of the ſphincter and rectum.

SECT. XII.

OF STIMULUS, SENSORIAL EXERTION, AND FIBROUS CONTRACTION.

I. Of fibrous contraction. 1. *Two particles of a fibre cannot approach without the intervention of ſomething, as in magnetiſm, electricity, elaſticity. Spirit of life is not electric ether. Galvani's experiments.* 2. *Contraction of a fibre.* 3. *Relaxation ſucceeds.* 4. *Succeſſive contractions, with intervals. Quick pulſe from debility, from paucity of blood. Weak contractions performed*

formed in leſs time, and with ſhorter intervals. 5. 5. *Laſt ſituation of the fibres continues after contraction.* 6. *Contraction greater than uſual induces pleaſure or pain.* 7. *Mobility of the fibres uniform. Quantity of ſenſorial power fluctuates. Conſtitutes excitability.* II. Of ſenſorial exertion. 1. *Animal motion includes ſtimulus, ſenſorial power, and contractile fibres. The ſenſorial faculties act ſeparately or conjointly. Stimulus of four kinds. Strength and weakneſs defined. Senſorial power perpetually exhauſted and renewed. Weakneſs from defect of ſtimulus. From defect of ſenſorial power, the direct and indirect debility of Dr. Brown. Why we become warm in Buxton bath after a time, and ſee well after a time in a darkiſh room. Fibres may act violently, or with their whole force, and yet feebly. Great exertion in inflammation explained. Great muſcular force of ſome inſane people.* 2. *Occaſional accumulation of ſenſorial power in muſcles ſubject to conſtant ſtimulus. In animals ſleeping in winter. In eggs, ſeeds, ſchirrous tumours, tendons, bones.* 3. *Great exertion introduces pleaſure or pain. Inflammation. Libration of the ſyſtem between torpor and activity. Fever-fits.* 4. *Deſire and averſion introduced. Exceſs of volition cures fevers.* III. Of repeated ſtimulus. 1. *A ſtimulus repeated too frequently loſes effect. As opium, wine, grief. Hence old age. Opium and aloes in ſmall doſes.* 2. *A ſtimulus not repeated too frequently does not loſe effect. Perpetual movement of the vital organs.* 3. *A ſtimulus repeated at uniform times produces greater effect. Irritation combined with aſſociation.* 4. *A ſtimulus repeated frequently and uniformly may be withdrawn, and the action of the organ will continue. Hence the bark cures agues, and ſtrengthens weak conſtitutions.* 5. *Defect of ſtimulus repeated at certain intervals cauſes fever-fits.* 6. *Stimulus long applied ceaſes to act a ſecond time.* 7. *If a ſtimulus excites ſenſation in an organ not uſually excited into ſenſation,*

ſation, inflammation is produced. IV. Of ſtimulus greater than natural. 1. *A ſtimulus greater than natural diminiſhes the quantity of ſenſorial power in in general.* 2. *In particular organs.* 3. *Induces the organ into ſpaſmodic actions.* 4. *Induces the antagoniſt fibres into action.* 5. *Induces the organ into convulſive or fixed ſpaſms.* 6. *Produces paralyſis of the organ.* V. Of ſtimulus leſs than natural. 1. *Stimulus leſs than natural occaſions accumulation of ſenſorial power in general.* 2. *In particular organs, fluſhing of the face in a froſty morning. In fibres ſubject to perpetual ſtimulus only. Quantity of ſenſorial power inverſely as the ſtimulus.* 3. *Induces pain. As of cold, hunger, head-ach.* 4. *Induces more feeble and frequent contraction. As in low fevers. Which are frequently owing to deficiency of ſenſorial power rather than to deficiency of ſtimulus.* 5. *Inverts ſucceſſive trains of motion. Inverts ideas.* 6. *Induces paralyſis and death.* VI. Cure of increaſed exertion. 1. *Natural cure of exhauſtion of ſenſorial power.* 2. *Decreaſe the irritations. Veneſection. Cold. Abſtinence.* 3. *Prevent the previous cold fit. Opium. Bark. Warmth. Anger. Surpriſe.* 4. *Excite ſome other part of the ſyſtem. Opium and warm bath relieve pains both from defect and from exceſs of ſtimulus.* 5. *Firſt increaſe the ſtimulus above, and then decreaſe it beneath the natural quantity.* VII. Cure of decreaſed exertion. 1. *Natural cure by accumulation of ſenſorial power. Ague-fits. Syncope.* 2. *Increaſe the ſtimulation, by wine, opium, given ſo as not to intoxicate. Cheerful ideas.* 3. *Change the kinds of ſtimulus.* 4. *Stimulate the aſſociated organs. Bliſters of uſe in heart-burn, and cold extremities.* 5. *Decreaſe the ſtimulation for a time, cold bath.* 6. *Decreaſe the ſtimulation below natural, and then increaſe it above natural. Bark after emetics. Opium after veneſection. Practice of Sydenham in chloroſis.* 7. *Prevent unneceſſary expenditure of ſenſorial power. Decumbent poſture, ſilence, darkneſs.*

neſs. Pulſe quickened by riſing out of bed. 8. *To the greateſt degree of quieſcence apply the leaſt ſtimulus. Otherwiſe paralyſis or inflammation of the organ enſues. Gin, wine, bliſters, deſtroy by too great ſtimulation in fevers with debility. Intoxication in the ſlighteſt degree ſucceeded by debility. Golden rule for determining the beſt degree of ſtimulus in low fevers. Another golden rule for determining the quantity of ſpirit, which thoſe, who are debilitated by drinking it, may ſafely omit.*

I. *Of fibrous contraction.*

1. IF two particles of iron lie near each other without motion, and afterwards approach each other; it is reaſonable to conclude that ſomething beſides the iron particles is the cauſe of their approximation; this inviſible ſomething is termed magnetiſm. In the ſame manner, if the particles, which compoſe an animal muſcle, do not touch other in the relaxed ſtate of the muſcle, and are brought into contact during the contraction of the muſcle; it is reaſonable to conclude, that ſome other agent is the cauſe of this new approximation. For nothing can act, where it does not exiſt; for to act includes to exiſt; and therefore the particles of the muſcular fibre (which in its ſtate of relaxation are ſuppoſed not to touch) cannot affect each other without the influence of ſome intermediate agent; this agent is here termed the ſpirit of animation, or ſenſorial power, but may with equal propriety be termed the power, which cauſes coutraction; or may be called by another name, which the reader may chooſe to affix to it.

The contraction of a muſcular fibre may be compared to the following electric experiment, which is here mentioned not as a philoſophical analogy, but as an illuſtration or ſimile to facilitate the conception

ception of a difficult ſubject. Let twenty very ſmall Leyden phials properly coated be hung in a row by fine ſilk threads at a ſmall diſtance from each other; let the internal charge of one phial be poſitive, and of the other negative alternately, if a communication be made from the internal ſurface of the firſt to the external ſurface of the laſt in the row, they will all of them inſtantly approach each other, and thus ſhorten a line that might connect them like a muſcular fibre. See Botanic Garden, p. 1. Canto I. l. 202, note on Gymnotus.

The attractions of electricity or of magnetiſm do not apply philoſophically to the illuſtration of the contraction of animal fibres, ſince the force of thoſe attractions increaſes in ſome proportion inverſely as the diſtance, but in muſcular motion there appears no difference in velocity or ſtrength during the beginning or end of the contraction, but what may be clearly aſcribed to the varying mechanic advantage in the approximation of one bone to another. Nor can muſcular motion be aſſimilated with greater plauſibility to the attraction of coheſion or elaſticity; for in bending a ſteel ſpring, as a ſmall ſword, a leſs force is required to bend it the firſt inch than the ſecond; and the ſecond than the third; the particles of ſteel on the convex ſide of the bent ſpring endeavouring to reſtore themſelves more powerfully the further they are drawn from each other. See Botanic Garden, P. 1. addit. Note XVIII.

I am aware that this may be explained another way, by ſuppoſing the elaſticity of the ſpring to depend more on the compreſſion of the particles on the concave ſide than on the extenſion of them on the convex ſide; and by ſuppoſing the elaſticity of the elaſtic gum to depend more on the reſiſtance to the lateral compreſſion of its particles than to the longitudinal extenſion of them. Nevertheleſs in muſcular

muſcular contraction, as above obſerved, there appears no difference in the velocity or force of it at its commencement or at its termination; from whence we muſt conclude that animal contraction is governed by laws of its own, and not by thoſe of mechanics, chemiſtry, magnetiſm, or electricity.

On theſe accounts I do not think the experiments concluſive, which were lately publiſhed by Galvani, Volta, and others, to ſhew a ſimilitude between the ſpirit of animation, which contracts the muſcular fibres, and the electric fluid. Since the electric fluid may act only as a more potent ſtimulus exciting the muſcular fibres into action, and not by ſupplying them with a new quantity of the ſpirit of life. Thus in a recent hemiplegia I have frequently obſerved, when the patient yawned and ſtretched himſelf, that the paralytic limbs moved alſo, though they were totally diſobedient to the will. And when he was electrified by paſſing ſhocks from the affected hand to the affected foot, a motion of the paralytic limbs was alſo produced. Now as in the act of yawning the muſcles of the paralytic limbs were excited into action by the ſtimulus of the irkſomeneſs of a continued poſture, and not by any additional quantity of the ſpirit of life; ſo we may conclude, that the paſſage of the electric fluid, which produced a ſimilar effect, acted only as a ſtimulus, and not by ſupplying any addition of ſenſorial power.

If nevertheleſs this theory ſhould ever become eſtabliſhed, a ſtimulus muſt be called an eductor of vital ether; which ſtimulus may conſiſt of ſenſation or volition, as in the electric eel, as well as in the appulſes of external bodies; and by drawing off the charges of vital fluid may occaſion the contraction or motions of the muſcular fibres, and organs of ſenſe.

2. The

2. The immediate effect of the action of the ſpirit of animation or ſenſorial power on the fibrous parts of the body, whether it acts in the mode of irritation, ſenſation, volition, or aſſociation, is a contraction of the animal fibre, according to the ſecond law of animal cauſation. Sect. IV. Thus the ſtimulus of the blood induces the contraction of the heart; the agreeable taſte of a ſtrawberry produces the contraction of the muſcles of deglutition; the effort of the will contracts the muſcles, which move the limbs in walking; and by aſſociation other muſcles of the trunk are brought into contraction to preſerve the balance of the body. The fibrous extremities of the organs of ſenſe have been ſhewn, by the ocular ſpectra in Sect. III. to ſuffer ſimilar contraction by each of the above modes of excitation; and by their configurations to conſtitute our ideas.

3. After animal fibres have for ſome time been excited into contraction, a relaxation ſucceeds, even though the exciting cauſe continues to act. In reſpect to the irritative motions this is exemplified in the periſtaltic contractions of the bowels; which ceaſe and are renewed alternately, though the ſtimulus of the aliment continues to be uniformly applied; in the ſenſitive motions, as in ſtrangury, teneſmus, and parturition, the alternate contractions and relaxations of the muſcles exiſt, though the ſtimulus is perpetual. In our voluntary exertions it is experienced, as no one can hang long by the hands, however vehemently he wills ſo to do; and in the aſſociate motions the conſtant change of our attitudes evinces the neceſſity of relaxation to thoſe muſcles, which have been long in action.

This relaxation of a muſcle after its contraction, even though the ſtimulus continues to be applied, appears to ariſe from the expenditure or diminution of the ſpirit of animation previouſly reſident in the muſcle,

muſcle, according to the ſecond law of animal cauſation in Sect. IV. In thoſe conſtitutions, which are termed weak, the ſpirit of animation becomes ſooner exhauſted, and tremulous motions are produced, as in the hands of infirm people, when they lift a cup to their mouths. The quicker exhauſtion of the ſpirit of animation is probably owing to a leſs quantity of it reſiding in the acting fibres, which therefore more frequently require a ſupply from the nerves, which belong to them.

4. If the ſenſorial power continues to act, whether it acts in the mode of irritation, ſenſation, volition, or aſſociation, a new contraction of the animal fibre ſucceeds after a certain interval; which interval is of ſhorter continuance in weak people than in ſtrong ones. This is exemplified in the ſhaking of the hands of weak people, when they attempt to write. In a manuſcript epiſtle of one of my correſpondents, which is written in a ſmall hand, I obſerved from four to ſix zigzags in the perpendicular ſtroke of every letter, which ſhews that both the contractions of the fingers, and intervals between them, muſt have been performed in very ſhort periods of time.

The times of contraction of the muſcles of enfeebled people being leſs, and the intervals between thoſe contractions being leſs alſo, accounts for the quick pulſe in fevers with debility, and in dying animals. The ſhortneſs of the intervals between one contraction and another in weak conſtitutions, is probably owing to the general deficiency of the quantity of the ſpirit of animation, and that therefore there is a leſs quantity of it to be received at each interval of the activity of the fibres. Hence in repeated motions, as of the fingers in performing on the harpſichord, it would at firſt ſight appear, that ſwiftneſs and ſtrength were incompatible; nevertheleſs the ſingle contraction of a muſcle

is

is performed with greater velocity as well as with greater force by vigorous conſtitutions, as in throwing a javelin.

There is however another circumſtance, which may often contribute to cauſe the quickneſs of the pulſe in nervous fevers, as in animals bleeding to death in the ſlaughter-houſe; which is the deficient quantity of blood; whence the heart is but half diſtended, and in conſequence ſooner contracts. See Sect. XXXII. 2. 1.

For we muſt not confound frequency of repetition with quickneſs of motion, or the number of pulſations with the velocity, with which the fibres, which conſtitute the coats of the arteries, contract themſelves. For where the frequency of the pulſations is but ſeventy-five in a minute, as in health; the contracting fibres, which conſtitute the ſides of the arteries, may move through a greater ſpace in a given time, than where the frequency of pulſation is one hundred and fifty in a minute, as in ſome fevers with great debility. For if in thoſe fevers the arteries do not expand themſelves in their diaſtole to more than half the uſual diameter of their diaſtole in health, the fibres which conſtitute their coats, will move through a leſs ſpace in a minute than in health, though they make two pulſations for one.

Suppoſe the diameter of the artery during its ſyſtole to be one line, and that the diameter of the ſame artery during its diaſtole is in health is four lines, and in a fever with great debility only two lines. It follows, that the arterial fibres contract in health from a circle of twelve lines in circumference to a circle of three lines in circumference, that is they move through a ſpace of nine lines in length. While the arterial fibres in the fever with debility would twice contract from a circle of ſix lines to a circle of three lines; that is while they move

move through a ſpace equal to ſix lines. Hence though the frequency of pulſation in fever be greater as two to one, yet the velocity of contraction in health is greater as nine to ſix, or as three to two.

On the contrary in inflammatory diſeaſes with ſtrength, as in the pleuriſy, the velocity of the contracting ſides of the arteries is much greater than in health, for if we ſuppoſe the number of pulſations in a pleuriſy to be half as much more than in health, that is as one hundred and twenty to eighty, (which is about what generally happens in inflammatory diſeaſes) and if the diameter of the artery in diaſtole be one third greater than in health, which I believe is near the truth, the reſult will be, that the velocity of the contractile ſides of the arteries will be in a pleuriſy as two and a half to one, compared to the velocity of their contraction in a ſtate of health, for if the circumference of the ſyſtole of the artery be three lines, and the diaſtole in health be twelve lines in circumference, and in a pleuriſy eighteen lines; and ſecondly, if the artery pulſates thrice in the diſeaſed ſtate for twice in the healthy one, it follows, that the velocity of contraction in the diſeaſed ſtate to that in the healthy ſtate will be forty-five to eighteen, or as two and a half to one.

From hence it would appear, that if we had a criterion to determine the velocity of the arterial contractions, it would at the ſame time give us their ſtrength, and thus be of more ſervice in diſtinguiſhing diſeaſes, than the knowledge of their frequency. As ſuch a criterion cannot be had, the frequency of pulſation, the age of the patient being allowed for, will in ſome meaſure aſſiſt us to diſtinguiſh arterial ſtrength from arterial debility, ſince in inflammatory diſeaſes with ſtrength the frequency ſeldom exceeds one hundred and eighteen or one

hundred

hundred and twenty pulſations in a minute; unleſs under peculiar circumſtance, as the great additional ſtimuli of wine or of external heat.

5. After a muſcle or organ of ſenſe has been excited into contraction, and the ſenſorial power ceaſes to act, the laſt ſituation or configuration of it continues; unleſs it be diſtributed by the action of ſome antagoniſt fibres, or other extraneous power. Thus in weak or languid people, wherever they throw their limbs on their bed or ſofa, there they lie, till another exertion changes their attitude; hence one kind of ocular ſpectra ſeems to be produced after looking at bright objects; thus when a fire-ſtick is whirled round in the night, there appears in the eye a complete circle of fire; the action or configuration of one part of the retina not ceaſing before the return of the whirling fire.

Thus if any one looks at the ſetting ſun for a ſhort time, and then covers his cloſed eyes with his hand, he will for many ſeconds of time perceive the image of the ſun on his retina. A ſimilar image of all other bodies would remain ſome time in the eye, but is effaced by the eternal change of the motions of the extremity of this nerve in our attention to other objects. See Sect. XVII. 1. 3. on Sleep. Hence the dark ſpots, and other ocular ſpectra, are more frequently attended to, and remain longer in the eyes of weak people, as after violent exerciſe, intoxication, or want of ſleep.

6. A contraction of the fibres ſomewhat greater than uſual introduces pleaſurable ſenſation into the ſyſtem, according to the fourth law of animal cauſation. Hence the pleaſure in the beginning of drunkenneſs is owing to the increaſed action of the ſyſtem from the ſtimulus of vinous ſpirit or of opium. If the contractions be ſtill greater in energy or duration, painful ſenſations are introduced,

as

as in conſequence of great heat, or cauſtic applications, or fatigue.

If any part of the ſyſtem, which is uſed to perpetual activity, as the ſtomach, or heart, or the fine veſſels of the ſkin, acts for a time with leſs energy, another kind of painful ſenſation enſues, which is called hunger, or faintneſs, or cold. This occurs in a leſs degree in the locomotive muſcles, and is called wearyſomeneſs. In the two former kinds of ſenſation there is an expenditure of ſenſorial power, in theſe latter there is an accumulation of it.

7. We have uſed the words exertion of ſenſorial power as a general term to expreſs either irritation, ſenſation, volition, or aſſociation; that is, to expreſs the activity or motion of the ſpirit of animation, at the time it produces the contractions of the fibrous parts of the ſyſtem. It may be ſuppoſed that there may exiſt a greater or leſs mobility of the fibrous parts of our ſyſtem, or a propenſity to be ſtimulated into contraction by the greater or leſs quantity or energy of the ſpirit of animation; and that hence if the exertion of the ſenſorial power be in its natural ſtate, and the mobility of the fibres be increaſed, the ſame quantity of fibrous contraction will be cauſed, as if the mobility of the fibres continues in its natural ſtate, and the ſenſorial exertion be increaſed.

Thus it may be conceived, that in diſeaſes accompanied with ſtrength, as in inflammatory fevers with arterial ſtrength, that the cauſe of greater fibrous contraction may exiſt in the increaſed mobility of the fibres, whoſe contractions are thence both more forceable and more frequent. And that in diſeaſes attended with debility, as in nervous fevers, where the fibrous contractions are weaker, and more frequent, it may be conceived that the cauſe conſiſts in a decreaſe of mobility of the fibres;

and

and that thoſe weak conſtitutions, which are attended with cold extremities and large pupils of the eyes, may poſſeſs leſs mobility of the contractile fibres, as well as leſs quantity of exertion of the ſpirit of animation.

In anſwer to this mode of reaſoning it may be ſufficient to obſerve, that the contractile fibres conſiſt of inert matter, and when the ſenſorial power is withdrawn, as in death, they poſſeſs no power of motion at all, but remain in their laſt ſtate, whether of contraction or relaxation, and muſt thence derive the whole of this property from the ſpirit of animation. At the ſame time it is not improbable, that the moving fibres of ſtrong people may poſſeſs a capability of receiving or containing a greater quantity of the ſpirit of animation than thoſe of weak people.

In every contraction of a fibre there is an expenditure of the ſenſorial power, or ſpirit of animation; and where the exertion of this ſenſorial power has been for ſome time increaſed, and the muſcles or organs of ſenſe have in conſequence acted with greater energy, its propenſity to activity is proportionally leſſened; which is to be aſcribed to the exhauſtion or diminution of its quantity. On the contrary, where there has been leſs fibrous contraction than uſual for a certain time, the ſenſorial power or animation becomes accumulated in the inactive part of the ſyſtem. Hence vigour ſucceeds reſt, and hence the propenſity to action of all our organs of ſenſe and muſcles is in a ſtate of perpetual fluctuation. The irritability for inſtance of the retina, that is, its quantity of ſenſorial power, varies every moment according to the brightneſs or obſcurity of the object laſt beheld compared with the preſent one. The ſame occurs to our ſenſe of heat, and to every part of our ſyſtem, which is capable of being excited into action.

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When this variation of the exertion of the ſenſorial power becomes much and permanently above or beneath the natural quantity, it becomes a diſeaſe. If the irritative motions be too great or too little, it ſhews that the ſtimulus of external things affects this ſenſorial power too violently or too inertly. If the ſenſitive motions be too great or too little, the cauſe ariſes from the deficient or exuberant quantity of ſenſation produced in conſequence of the motions of the muſcular fibres or organs of ſenſe; if the voluntary actions are diſeaſed, the cauſe is to be looked for in the quantity of volition produced in conſequence of the deſire or averſion occaſioned by the painful or pleaſurable ſenſations above mentioned. And the diſeaſes of aſſociations probably depend on the greater or leſs quantity of the other three ſenſorial powers by which they were formed.

From whence it appears that the propenſity to action, whether it be called irritability, ſenſibility, voluntarity, or aſſociability, is only another mode of expreſſion for the quantity of ſenſorial power reſiding in the organ to be excited. And that on the contrary the words inirritability and inſenſibility, together with inaptitude to voluntary and aſſociate motions, are ſynonymous with deficiency of the quantity of ſenſorial power, or of the ſpirit of animation, reſiding in the organs to be excited.

II. *Of ſenſorial Exertion.*

1. There are three circumſtances to be attended to in the production of animal motions. 1ſt. The ſtimulus. 2d. The ſenſorial power. 3d. The contractile fibre. 1ſt. A ſtimulus, external to the organ, originally induces into action the ſenſorial faculty termed irritation; this produces the contraction of the fibres, which if it be perceived at all,

introduces pleaſure or pain; which in their active ſtate are termed ſenſation; which is another ſenſorial faculty, and occaſionally produces contraction of the fibres; this pleaſure or pain is therefore to be conſidered as another ſtimulus, which may either act alone or in conjunction with the former faculty of the ſenſorium termed irritation. This new ſtimulus of pleaſure or pain either induces into action the ſenſorial faculty termed ſenſation, which then produces the contraction of the fibres; or it introduces deſire or averſion, which excite into action another ſenſorial faculty, termed volition, and may therefore be conſidered as another ſtimulus, which either alone, or in conjunction with one or both of the two former faculties of the ſenſorium, produces the contraction of animal fibres. There is another ſenſorial power, that of aſſociation, which perpetually, in conjunction with one or more of the above, and frequently ſingly, produces the contraction of animal fibres, and which is itſelf excited into action by the previous motions of contracting fibres.

Now as the ſenſorial power, termed irritation, reſiding in any particular fibres, is excited into exertion by the ſtimulus of external bodies acting on thoſe fibres; the ſenſorial power, termed ſenſation, reſiding in any particular fibres is excited into exertion by the ſtimulus of pleaſure or pain acting on thoſe fibres; the ſenſorial power, termed volition, reſiding in any particular fibres is excited into exertion by the ſtimulus of deſire or averſion; and the ſenſorial power termed aſſociation, reſiding in any particular fibres, is excited into action by the ſtimulus of other fibrous motions, which had frequently preceded them. The word ſtimulus may therefore be uſed without impropriety of language, for any of theſe four cauſes, which excite the four

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ſenſorial powers into exertion. For though the immediate cauſe of volition has generally been termed *a motive*; and that of irritation only has generally obtained the name of *ſtimulus*; yet as the immediate cauſe, which excites the ſenſorial powers of ſenſation, or of aſſociation into exertion, have obtained no general name, we ſhall uſe the word ſtimulus for them all.

Hence the quantity of motion produced in any particular part of the animal ſyſtem will be as the quantity of ſtimulus and the quantity of ſenſorial power, or ſpirit of animation, reſiding in the contracting fibres. Where both theſe quantities are great *ſtrength* is produced, when that word is applied to the motions of animal bodies. Where either of them is deficient, *weakneſs* is produced, as applied to the motions of animal bodies.

Now as the ſenſorial power, or ſpirit of animation, is perpetually exhauſted by the expenditure of it in fibrous contractions, and is perpetually renewed by the ſecretion or production of it in the brain and ſpinal marrow, the quantity of animal ſtrength muſt be in a perpetual ſtate of fluctuation on this account; and if to this be added the unceaſing variation of all the four kinds of ſtimulus above deſcribed, which produce the exertions of the ſenſorial powers, the ceaſeleſs viciſſitude of animal ſtrength becomes eaſily comprehended.

If the quantity of ſenſorial power remains the ſame, and the quantity of ſtimulus be leſſened, a weakneſs of the fibrous contractions enſues, which may be denominated *debility from defect of ſtimulus*. If the quantity of ſtimulus remains the ſame, and the quantity of ſenſorial power be leſſened, another kind of weakneſs enſues, which may be termed *debility from defect of ſenſorial power*; the former of

theſe is called by Dr. Brown, in his Elements of Medicine, direct debility, and the latter indirect debility. The coincidence of ſome parts of this work with correſpondent deductions in the Brunonian Elementa Medicinæ, a work (with ſome exceptions) of great genius, muſt be conſidered as confirmations of the truth of the theory, as they were probably arrived at by different trains of reaſoning.

Thus in thoſe who have been expoſed to cold and hunger there is a deficiency of ſtimulus. While in nervous fever there is a deficiency of ſenſorial power. And in habitual drunkards, in a morning before their uſual potation, there is a deficiency both of ſtimulus and of ſenſorial power. While, on the other hand, in the beginning of intoxication there is an exceſs of ſtimulus; in the hot-ach, after the hands have been immerſed in ſnow, there is a redundancy of ſenſorial power; and in inflammatory diſeaſes with arterial ſtrength, there is an exceſs of both.

Hence if the ſenſorial power be leſſened, while the quantity of ſtimulus remains the ſame as in nervous fever, the frequency of repetition of the arterial contractions may continue, but their force in reſpect to removing obſtacles, as in promoting the circulation of the blood, or the velocity of each contraction, will be diminiſhed, that is, the animal ſtrength will be leſſened. And ſecondly, if the quantity of ſenſorial power be leſſened, and the ſtimulus be increaſed to a certain degree, as in giving opium in nervous fevers, the arterial contractions may be performed more frequently than natural, yet with leſs ſtrength.

And thirdly, if the ſenſorial power continues the ſame in reſpect to quantity, and the ſtimulus be ſomewhat diminiſhed, as in going into a darkiſh room, or into a coldiſh bath, ſuppoſe of about eighty degrees of heat, as Buxton-bath, a tempo-

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rary weakneſs of the affected fibres is induced, till an accumulation of ſenſorial power gradually ſucceeds, and counterbalances the deficiency of ſtimulus, and then the bath ceaſes to feel cold, and the room ceaſes to appear dark; becauſe the fibres of the ſubcutaneous veſſels, or of the organs of ſenſe, act with their uſual energy.

A ſet of muſcular fibres may thus be ſtimulated into violent exertion, that is, they may act frequently, and with their whole ſenſorial power, but may nevertheleſs not act ſtrongly; becauſe the quantity of their ſenſorial power was originally ſmall, or was previouſly exhauſted. Hence a ſtimulus may be great, and the irritation in conſequence act with its full force, as in the hot paroxyſms of nervous fever; but if the ſenſorial power, termed irritation, be ſmall in quantity, the force of the fibrous contractions, and the times of their continuance in their contracted ſtate, will be proportionally ſmall.

In the ſame manner in the hot paroxyſm of putrid fevers, which are ſhewn in Sect. XXXIII. to be inflammatory fevers with arterial debility, the ſenſorial power termed ſenſation is exerted with great activity, yet the fibrous contractions, which produce the circulation of the blood, are performed without ſtrength, becauſe the quantity of ſenſorial power then reſiding in that part of the ſyſtem is ſmall.

Thus in irritative fever with arterial ſtrength, that is, with exceſs of ſpirit of animation, the quantity of exertion during the hot part of the paroxyſm is to be eſtimated from the quantity of ſtimulus, and the quantity of ſenſorial power. While in ſenſitive (or inflammatory) fever with arterial ſtrength, that is, with exceſs of ſpirit of animation, the violent and forcible actions of the vaſcular ſyſtem during the hot part of the paroxyſm are induced by the exertions of two ſenſorial powers, which are excited

excited by two kinds of ſtimulus. Theſe are the ſenſorial power of irritation excited by the ſtimulus of bodies external to the moving fibres, and the ſenſorial power of ſenſation excited by the pain in conſequence of the increaſed contractions of thoſe moving fibres.

And in inſane people in ſome caſes the force of their muſcular actions will be in proportion to the quantity of ſenſorial power, which they poſſeſs, and the quantity of the ſtimulus of deſire or averſion, which excites their volition into action. At the ſame time in other caſes the ſtimulus of pain or pleaſure, and the ſtimulus of external bodies, may excite into action the ſenſorial powers of ſenſation and irritation, and thus add greater force to their muſcular actions.

2. The application of the ſtimulus, whether that ſtimulus be ſome quality of external bodies, or pleaſure or pain, or deſire or averſion, or a link of aſſociation, excites the correſpondent ſenſorial power into action, and this cauſes the contraction of the fibre. On the contraction of the fibre a part of the ſpirit of animation becomes expended, and the fibre ceaſes to contract, though the ſtimulus continues to be applied; till in a certain time the fibre having received a ſupply of ſenſorial power is ready to contract again, if the ſtimulus continues to be applied. If the ſtimulus on the contrary be withdrawn, the ſame quantity of quieſcent ſenſorial power becomes reſident in the fibre as before its contraction; as appears from the readineſs for action of the large locomotive muſcles of the body in a ſhort time after common exertion.

But in thoſe muſcular fibres, which are ſubject to conſtant ſtimulus, as the arteries, glands, and capillary veſſels, another phenomenon occurs, if their accuſtomed ſtimulus be withdrawn; which is, that the ſenſorial power becomes accumulated in the contractile

contractile fibres, owing to the want of its being perpetually expended, or carried away, by their uſual unremitted contractions. And on this account thoſe muſcular fibres become afterwards excitable into their natural actions by a much weaker ſtimulus; or into unnatural violence of action by their accuſtomed ſtimulus, as is ſeen in the hot fits of intermittent fevers, which are in conſequence of the previous cold ones. Thus the minute veſſels of the ſkin are conſtantly ſtimulated by the fluid matter of heat; if the quantity of this ſtimulus of heat be a while diminiſhed, as in covering the hands with ſnow, the veſſels ceaſe to act, as appears from the paleneſs of the ſkin; if this cold application of ſnow be continued but a ſhort time, the ſenſorial power, which had habitually been ſupplied to the fibres, becomes now accumulated in them, owing to the want of its being expended by their accuſtomed contractions. And thence a leſs ſtimulus of heat will now excite them into violent contractions.

If the quieſcence of fibres, which had previouſly been ſubject to perpetual ſtimulus, continues a longer time; or their accuſtomed ſtimulus be more completely withdrawn; the accumulation of ſenſorial power becomes ſtill greater, as in thoſe expoſed to cold and hunger; pain is produced, and the organ gradually dies from the chemical changes, which take place in it; or it is at a great diſtance of time reſtored to action by ſtimulus applied with great caution in ſmall quantity, as happens to ſome larger animals and to many inſects, which during the winter months lie benumbed with cold, and are ſaid to ſleep, and to perſons apparently drowned, or apparently frozen to death. Snails have been ſaid to revive by throwing them into water after having been many years ſhut up in the cabinets of the curious;

curious; and eggs and ſeeds in general are reſtored to life after many months of torpor by the ſtimulus of warmth and moiſture.

The inflammation of ſchirrous tumours, which have long exiſted in a ſtate of inaction, is a proceſs of this kind; as well as the ſenſibility acquired by inflamed tendons and bones, which had at their formation a ſimilar ſenſibility, which had ſo long lain dormant in their uninflamed ſtate.

3. If after long quieſcence from defect of ſtimulus the fibres, which had previouſly been habituated to perpetual ſtimulus, are again expoſed to but their uſual quantity of it; as in thoſe who have ſuffered the extremes of cold or hunger; a violent exertion of the affected organ commences, owing, as above explained, to the great accumulation of ſenſorial power. This violent exertion not only diminiſhes the accumulated ſpirit of animation, but at the ſame time induces pleaſure or pain into the ſyſtem, which, whether it be ſucceeded by inflammation or not, becomes an additional ſtimulus, and acting along with the former one, produces ſtill greater exertions; and thus reduces the ſenſorial power in the contracting fibres beneath its natural quantity.

When the ſpirit of animation is thus exhauſted by uſeleſs exertions, the organ becomes torpid or unexcitable into action, and a ſecond fit of quieſcence ſucceeds that of abundant activity. During this ſecond fit of quieſcence the ſenſorial power becomes again accumulated, and another fit of exertion follows in train. Theſe viciſſitudes of exertion and inertion of the arterial ſyſtem conſtitute the paroxyſms of remittent fevers; or intermittent ones, when there is an interval of the natural action of the arteries between the exacerbations.

In theſe paroxyſms of fevers, which conſiſt of the libration of the arterial ſyſtem between the extremes

tremes of exertion and quieſcence, either the fits become leſs and leſs violent from the contractile fibres becoming leſs excitable to the ſtimulus by habit, that is, by becoming accuſtomed to it, as explained below XII. 3. 1. or the whole ſenſorial power becomes exhauſted, and the arteries ceaſe to beat, and the patient dies in the cold part of the paroxyſm. Or ſecondly, ſo much pain is introduced into the ſyſtem by the violent contractions of the fibres, that inflammation ariſes, which prevents future cold fits by expending a part of the ſenſorial power in the extenſion of old veſſels or the production of new ones; and thus preventing the too great accumulation or exertion of it in other parts of the ſyſtem; or which by the great increaſe of ſtimulus excites into great action the whole glandular ſyſtem as well as the arterial, and thence a greater quantity of ſenſorial power is produced in the brain, and thus its exhauſtion in any peculiar part of the ſyſtem ceaſes to be affected.

4. Or thirdly, in conſequence of the painful or pleaſurable ſenſation above mentioned, deſire and averſion are introduced, and inordinate volition ſucceeds; which by its own exertions expends ſo much of the ſpirit of animation, that the two other ſenſorial faculties, or irritation and ſenſation, act ſo much more feebly; that the paroxyſms of fever, or that libration between the extremes of exertion and inactivity of the arterial ſyſtem, gradually ſubſides. On this account a temporary inſanity is a favourable ſign in fevers, as I have had ſome opportunities of obſerving.

III. *Of repeated Stimulus.*

1. When a ſtimulus is repeated more frequently than the expenditure of ſenſorial power can be renewed in the acting organ, the effect of the ſtimulus

lus becomes gradually diminiſhed. Thus if two grains of opium be ſwallowed by a perſon unuſed to ſo ſtrong a ſtimulus, all the vaſcular ſyſtems in the body act with greater energy, all the ſecretions and the abſorption from thoſe ſecreted fluids are increaſed in quantity; and pleaſure or plain are introduced into the ſyſtem, which adds an additional ſtimulus to that already too great. After ſome hours the ſenſorial power becomes diminiſhed in quantity, expended by the great activity of the ſyſtem; and thence, when the ſtimulus of the opium is withdrawn, the fibres will not obey their uſual degree of natural ſtimulus, and a conſequent torpor or quieſcence ſucceeds, as is experienced by drunkards, who on the day after a great exceſs of ſpirituous potation feel indigeſtion, head-ach, and general debility.

In this fit of torpor or quieſcence of a part or of the whole of the ſyſtem, an accumulation of the ſenſorial power in the affected fibres is formed, and occaſions a ſecond paroxyſm of exertion by the application only of the natural ſtimulus, and thus a libration of the ſenſorial exertion between one exceſs and the other continues for two or three days, where the ſtimulus was violent in degree; and for weeks in ſome fevers, from the ſtimulus of contagious matter.

But if a ſecond doſe of opium be exhibited before the fibres have regained their natural quantity of ſenſorial power, its effect will be much leſs than the former, becauſe the ſpirit of animation or ſenſorial power is in part exhauſted by the previous exceſs of exertion. Hence all medicines repeated too frequently gradually loſe their effect, as opium and wine. Many things of diſagreeable taſte at firſt ceaſe to be diſagreeable by frequent repetition, as tobacco; grief and pain gradually diminiſh, and

at

at length ceaſe altogether, and hence life itſelf becomes tolerable.

Beſides the temporary diminution of the ſpirit of animation or ſenſorial power, which is naturally ſtationary or reſident in every living fibre, by a ſingle exhibition of a powerful ſtimulus, the contractile fibres themſelves, by the perpetual application of a new quantity of ſtimulus, before they have regained their natural quantity of ſenſorial power, appear to ſuffer in their capability of receiving ſo much as the natural quantity of ſenſorial power; and hence a permanent deficiency of ſpirit of animation takes place, however long the ſtimulus may have been withdrawn. On this cauſe depends the permanent debility of thoſe, who have been addicted to intoxication, the general weakneſs of old age, and the natural debility or inirritability of thoſe, who have pale ſkins and large pupils of their eyes.

There is a curious phenomenon belongs to this place, which has always appeared difficult of ſolution; and that is, that opium or aloes may be exhibited in ſmall doſes at firſt, and gradually increaſed to very large ones without producing ſtupor or diarrhœa. In this caſe, though the opium and aloes are given in ſuch ſmall doſes as not to produce intoxication or catharſis, yet they are exhibited in quantities ſufficient in ſome degree to exhauſt the ſenſorial power, and hence a ſtronger and a ſtronger doſe is required; otherwiſe the medicine would ſoon ceaſe to act at all.

On the contrary, if the opium or aloes be exhibited in a large doſe at firſt, ſo as to produce intoxication or diarrhœa; after a few repetitions the quantity of either of them may be diminiſhed, and they will ſtill produce this effect. For the more powerful ſtimulus diſſevers the progreſſive catenations of animal motions, deſcribed in Sect. XVII.

and

and introduces a new link between them; whence every repetition ſtrengthens this new aſſociation or catenation, and the ſtimulus may be gradually decreaſed, or be nearly withdrawn, and yet the effect ſhall continue; becauſe the ſenſorial power of aſſociation or catenation being united with the ſtimulus, increaſes in energy with every repetition of the catenated circle; and it is by theſe means that all the irritative aſſociations of motions are originally produced.

2. When a ſtimulus is repeated at ſuch diſtant intervals of time, that the natural quantity of ſenſorial power becomes completely reſtored in the acting fibres, it will act with the ſame energy as when firſt applied. Hence thoſe who have lately accuſtomed themſelves to large doſes of opium by beginning with ſmall ones, and gradually increaſing them, and repeating them frequently, as mentioned in the preceding paragraph; if they intermit the uſe of it for a few days only, muſt begin again with as ſmall doſes as they took at firſt, otherwiſe they will experience the inconveniences of intoxication.

On this circumſtance depend the conſtant unfailing effects of the various kinds of ſtimulus, which excite into action all the vaſcular ſyſtems in the body; the arterial, venous, abſorbent, and glandular veſſels, are brought into perpetual unwearied action by the fluids, which are adapted to ſtimulate them; but theſe have the ſenſorial power of aſſociation added to that of irritation, and even in ſome degree that of ſenſation, and even of volition, as will be ſpoken of in their places; and life itſelf is thus carried on by the production of ſenſorial power being equal to its waſte or expenditure in the perpetual movement of the vaſcular organization.

3. When

3. When a ſtimulus is repeated at uniform intervals of time with ſuch diſtances between them, that the expenditure of ſenſorial power in the acting fibres becomes completely renewed, the effect is produced with greater facility or energy. For the ſenſorial power of aſſociation is combined with the ſenſorial power of irritation, or, in common language, the acquired habit aſſiſts the power of the ſtimulus.

This circumſtance not only obtains in the annual and diurnal catenations of animal motions explained in Sect. XXXVI. but in every leſs circle of actions or ideas, as in the burthen of a ſong, or the iterations of a dance; and conſtitutes the pleaſure we receive from repetition and imitation; as treated of in Sect. XXII. 2.

4. When a ſtimulus has been many times repeated at uniform intervals, ſo as to produce the complete action of the organ, it may then be gradually diminiſhed, or totally withdrawn, and the action of the organ will continue. For the ſenſorial power of aſſociation becomes united with that of irritation, and by frequent repetition becomes at length of ſufficient energy to carry on the new link in the circle of actions, without the irritation which at firſt introduced it.

Hence, when the bark is given at ſtated intervals for the cure of intermittent fevers, if ſixty grains of it be given every three hours for the twenty-four hours preceding the expected paroxyſm, ſo as to ſtimulate the defective part of the ſyſtem into action, and by that means to prevent the torpor or quieſcence of the fibres, which conſtitutes the cold fit; much leſs than half the quantity, given before the time at which another paroxyſm of quieſcence would have taken place, will be ſufficient to prevent it; becauſe now the ſenſorial power, termed aſſociation, acts in a twofold manner,

manner. Firſt, in reſpect to the period of the catenation in which the cold fit was produced, which is now diſſevered by the ſtronger ſtimulus of the firſt doſes of the bark; and, ſecondly, becauſe each doſe of bark being repeated at periodical times, has its effect increaſed by the ſenſorial faculty of aſſociation being combined with that of irritation.

Now, when ſixty grains of Peruvian bark are taken twice a day, ſuppoſe at ten o'clock and at ſix, for a fortnight, the irritation excited by this additional ſtimulus becomes a part of the diurnal circle of actions, and will at length carry on the increaſed action of the ſyſtem without the aſſiſtance of the ſtimulus of the bark. On this theory the bitter medicines, chalybeates, and opiates in appropriated doſes, exhibited for a fortnight, give permanent ſtrength to pale feeble children, and other weak conſtitutions.

5. When a defect of ſtimulus, as of heat, recurs at certain diurnal intervals, which induces ſome torpor or quieſcence of a part of the ſyſtem, the diurnal catenation of actions becomes diſordered, and a new aſſociation with this link of torpid action is formed; on the next period the quantity of quieſcence will be increaſed, ſuppoſe the ſame defect of ſtimulus to recur, becauſe now the new aſſociation conſpires with the defective irritation in introducing the torpid action of this part of the diurnal catenation. In this manner many fever-fits commence, where the patient is for ſome days indiſpoſed at certain hours, before the cold paroxyſm of fever is completely formed. See Sect. XVII. 3. 3. on Catenation of Animal Motions.

6. If a ſtimulus, which at firſt excited the affected organ into ſo great exertion as to produce ſenſation, be continued for a certain time, it will ceaſe to produce ſenſation both then and when repeated, though

though the irritative motions in conſequence of it may continue or be re-excited.

Many catenations of irritative motions were at firſt ſucceeded by ſenſation, as the apparent motions of objects when we walk paſt them, and probably the vital motions themſelves in the early ſtate of our exiſtence. But as thoſe ſenſations were followed by no movements of the ſyſtem in conſequence of them, they gradually ceaſed to be produced, not being joined to any ſucceeding link of catenation. Hence contagious matter, which has for ſome weeks ſtimulated the ſyſtem into great and permanent ſenſation, ceaſes afterwards to produce general ſenſation or inflammation, though it may ſtill induce topical irritations. See Sect. XXXIII. 2. 8. XIX. 10.

Our abſorbent ſyſtem then ſeems to receive thoſe contagious matters, which it has before experienced, in the ſame manner as it imbibes common moiſture or other fluids; that is, without being thrown into ſo violent action as to produce ſenſation; the conſequence of which is an increaſe of daily energy or activity, till inflammation and its conſequences ſucceed.

7. If a ſtimulus excites an organ into ſuch violent contractions as to produce ſenſation, the motions of which organ had not uſually produced ſenſation, this new ſenſorial power, added to the irritation occaſioned by the ſtimulus, increaſes the activity of the organ. And if this activity be catenated with the diurnal circle of actions, an increaſing inflammation is produced; as in the evening paroxyſms of ſmall-pox, and other fevers with inflammation. And hence ſchirrous tumours, tendons and membranes, and probably the arteries themſelves become inflamed, when they are ſtrongly ſtimulated.

IV. *Of Stimulus greater than natural.*

1. A quantity of ſtimulus greater than natural, producing an increaſed exertion of ſenſorial power, whether that exertion be in the mode of irritation, ſenſation, volition, or aſſociation, diminiſhes the general quantity of it. This fact is obſervable in the progreſs of intoxication, as the increaſed quantity or energy of the irritative motions, owing to the ſtimulus of vinous ſpirit, introduces much pleaſurable ſenſation into the ſyſtem, and much exertion of muſcular or ſenſual motions in conſequence of this increaſed ſenſation; the voluntary motions, and even the aſſociate ones, become much impaired or diminiſhed; and delirium and ſtaggering ſucceed. See Sect. XXI. on Drunkenneſs. And hence the great proſtration of the ſtrength of the locomotive muſcles in ſome fevers, is owing to the exhauſtion of ſenſorial power by the increaſed action of the arterial ſyſtem.

In like manner a ſtimulus greater than natural, applied to a part of the ſyſtem, increaſes the exertion of ſenſorial power in that part, and diminiſhes it in ſome other part. As in the commencement of ſcarlet fever, it is uſual to ſee great redneſs and heat on the faces and breaſts of children, while at the ſame time their feet are colder than natural; partial heats are obſervable in other fevers with debility, and are generally attended with torpor or quieſcence of ſome other part of the ſyſtem. But theſe partial exertions of ſenſorial power are ſometimes attended with increaſed partial exertions in other parts of the ſyſtem, which ſympathzie with them, as the fluſhing of the face after a full meal. Both theſe therefore are to be aſcribed to ſympathetic aſſociations, explained in Sect. XXXV. and

not

not to general exauſtion or accumulation of ſenſorial power.

2. A quantity of ſtimulus greater than natural, producing an increaſed exertion of ſenſorial power in any particular organ, diminiſhes the quantity of it in that organ. This appears from the contractions of animal fibres being not ſo eaſily excited by a leſs ſtimulus after the organ has been ſubjected to a greater. Thus after looking at any luminous object of a ſmall ſize, as at the ſetting ſun, for a ſhort time, ſo as not much to fatigue the eye, this part of the retina becomes leſs ſenſible to ſmaller quantities of light; hence when the eyes are turned on other leſs luminous parts of the ſky, a dark ſpot is ſeen reſembling the ſhape of the ſun, or other luminous object which we laſt behold. See Sect. XL. No. 2.

Thus we are ſome time before we can diſtinguiſh objects in an obſcure room after coming from bright day-light, though the iris preſently contracts itſelf. We are not able to hear weak ſounds after loud ones. And the ſtomachs of thoſe who have been much habituated to the ſtronger ſtimulus of fermented or ſpirituous liquors, are not excited into due action by weaker ones.

3. A quantity of ſtimulus ſomething greater than the laſt mentioned, or longer continued, induces the organ into ſpaſmodic action, which ceaſes and recurs alternately. Thus on looking for a time on the ſetting ſun, ſo as not greatly to fatigue the ſight, a yellow ſpectrum is ſeen when the eyes are cloſed and covered, which continues for a time, and then diſappears and recurs repeatedly before it entirely vaniſhes. See Sect. XL. No. 5. Thus the action of vomiting ceaſes and is renewed by intervals, although the emetic drug is thrown up with the firſt effort. A teneſmus continues by intervals ſome time after the excluſion of acrid

excrement; and the pulſations of the heart of a viper are ſaid to continue ſome time after it is cleared from its blood.

In theſe caſes the violent contractions of the fibres produce pain according to law 4; and this pain conſtitutes an additional kind or quantity of excitement, which again induces the fibres into contraction, and which painful excitement is again renewed, and again induces contractions of the fibres with gradually diminiſhing effect.

4. A quantity of ſtimulus greater than the laſt mentioned, or longer continued, induces the antagoniſt muſcles into ſpaſmodic action. This is beautifully illuſtrated by the ocular ſpectra deſcribed in Sect. XL. No. 6. to which the reader is referred. From thoſe experiments there is reaſon to conclude that the fatigued part of the retina throws itſelf into a contrary mode of action like oſcitation or pandiculation, as ſoon as the ſtimulus, which has fatigued it, is withdrawn; but that it ſtill remains liable to be excited into action by any other colours except the colour with which it has been fatigued. Thus the yawning and ſtretching the limbs after a continued action or attitude ſeems occaſioned by the antagoniſt muſcles being ſtimulated by their extenſion during the contractions of thoſe in action, or in the ſituation in which that action laſt left them.

5. A quantity of ſtimulus greater than the laſt, or longer continued, induces variety of convulſions or fixed ſpaſms either of the affected organ or of the moving fibres in the other parts of the body. In reſpect to the ſpectra in the eye, this is well illuſtrated in No. 7. and 8, of Sect XL. Epileptic convulſions, as theemproſthotonos and opiſthotonos, with the cramp of the calf of the leg, locked jaw, and other cataleptic fits, appear to originate from pain, as ſome of theſe patients ſcream aloud before

fore the convulſion takes place; which ſeems at firſt to be an effort to relieve painful ſenſation, and afterwards an effort to prevent it.

In theſe caſes the violent contractions of the fibres produce ſo much pain, as to conſtitute a perpetual excitement; and that in ſo great a degree as to allow but ſmall intervals of relaxation of the contracting fibres as in convulſions, or no intervals at all as in fixed ſpaſms.

6. A quantity of ſtimulus greater than the laſt, or longer continued, produces a paralyſis of the organ. In many caſes this paralyſis is only a temporary effect, as on looking long on a ſmall area of bright red ſilk placed on a ſheet of white paper on the floor in a ſtrong light, the red ſilk gradually becomes paler, and at length diſappears; which evinces that a part of the retina, by being violently excited, becomes for a time unaffected by the ſtimulus of that colour. Thus cathartic medicines, opiates, poiſons, contagious matter, ceaſe to influence our ſyſtem after it has been habituated to the uſe of them, except by the exhibition of increaſed quantities of them; our fibres not only become unaffected by ſtimuli, by which they have previouſly been violently irritated, as by the matter of the ſmall-pox or meaſles; but they alſo become unaffected by ſenſation, where the violent exertions, which diſabled them, were in conſequence of too great quantity of ſenſation. And laſtly, the fibres, which become diſobedient to volition, are probably diſabled by their too violent exertions in conſequence of too great a quantity of volition.

After every exertion of our fibres a temporary paralyſis ſucceeds, whence the intervals of all muſcular contractions, as mentioned in No. 3 and 4 of this Section; the immediate cauſe of theſe more permanent kinds of paralyſis is probably owing in

the ſame manner to the too great exhauſtion of the ſpirit of animation in the affected part; ſo that a ſtronger ſtimulus is required, or one of a different kind from that, which occaſioned thoſe too violent contractions, to again excite the affected organ into activity; and if a ſtronger ſtimulus could be applied, it muſt again induce paralyſis.

For theſe powerful ſtimuli excite pain at the ſame time, that they produce irritation; and this pain not only excites fibrous motions by its ſtimulus, but it alſo produces volition; and thus all theſe ſtimuli acting at the ſame time, and ſometimes with the addition of their aſſociations, produce ſo great exertion as to expend the whole of the ſenſorial power in the affected fibres.

V. *Of Stimulus leſs than natural.*

1. A quantity of ſtimulus leſs than natural, producing a decreaſed exertion of ſenſorial power, occaſions an accumulation of the general quantity of it. This circumſtance is obſervable in the hemiplagia, in which the patients are perpetually moving the muſcles, which are unaffected. On this account we awake with greater vigour after ſleep, becauſe during ſo many hours, the great uſual expenditure of ſenſorial power in the performance of voluntary actions, and in the exertions of our organs of ſenſe, in conſequence of the irritations occaſioned by external objects, had been ſuſpended, and a conſequent accumulation had taken place.

In like manner the exertion of the ſenſorial power leſs than natural in one part of the ſyſtem, is liabls to produce an increaſe of the exertion of it in ſome other part. Thus by the action of vomiting, in which the natural exertions of the motions of the ſtomach are deſtroyed or diminiſhed, an increaſed

creaſed abſorption of the pulmonary and cellular lymphatics is produced, as is known by the increaſed abſorption of the fluid depoſited in them in dropſical caſes. But theſe partial quieſcences of ſenſorial power are alſo ſometimes attended with other partial quieſcences, which ſympathiſe with them, as cold and pale extremities from hunger. Theſe therefore are to be aſcribed to the aſſociations of ſympathy explained in Sect. XXXV. and not to the general accumulation of ſenſorial power.

2. A quantity of ſtimulus leſs than natural, applied to fibres previouſly accuſtomed to perpetual ſtimulus, is ſucceeded by accumulation of ſenſorial power in the affected organ. The truth of this propoſition is evinced, becauſe a ſtimulus leſs than natural, if it be ſomewhat greater than that above mentioned, will excite the organ ſo circumſtanced into violent activity. Thus on a froſty day with wind, the face of a perſon expoſed to the wind is at firſt pale and ſhrunk; but on turning the face from the wind, it becomes ſoon of a glow with warmth and fluſhing. The glow of the ſkin in emerging from the cold-bath is owing to the ſame cauſe.

It does not appear, that an accumulation of ſenſorial power above the natural quantity is acquired by thoſe muſcles, which are not ſubject to perpetual ſtimulus, as the locomotive muſcles: theſe, after the greateſt fatigue, only acquire by reſt their uſual aptitude to motion; whereas the vaſcular ſyſtem, as the heart and arteries, after a ſhort quieſcence, are thrown into violent action by their natural quantity of ſtimulus.

Nevertheleſs by this accumulation of ſenſorial power during the application of decreaſed ſtimulus, and by the exhauſtion of it during the action of increaſed ſtimulus, it is wiſely provided, that the actions of the vaſcular muſcles and organs of ſenſe

are

are not much deranged by ſmall variations of ſtimulus; as the quantity of ſenſorial power becomes in ſome meaſure inverſely as the quantity of ſtimulus.

3. A quantity of ſtimulus leſs than that mentioned above, and continued for ſome time, induces pain in the affected organ, as the pain of cold in the hands, when they are immerſed in ſnow, is owing to a deficiency of the ſtimulation of heat. Hunger is a pain from the deficiency of the ſtimulation of food. Pain in the back at the commencement of ague-fits, and the head-achs which attend feeble people, are pains from defect of ſtimulus, and are hence relieved by opium, eſſential oils, ſpirit of wine.

As the pains, which originate from defect of ſtimulus, only occur in thoſe parts of the ſyſtem, which have been previouſly ſubjected to perpetual ſtimulus; and as an accumulation of ſenſorial power is produced in the quieſcent organ along with the pain, as in cold or hunger, there is reaſon to believe, that the pain is owing to the accumulation of ſenſorial power. For, in the locomotive muſcles, in the retina of the eye, and other organs of ſenſes, no pain occurs from the abſence of ſtimulus, nor any great accumulation of ſenſorial power beyond their natural quantity, ſince theſe organs have not been uſed to a perpetual ſupply of it. There is indeed a greater accumulation occurs in the organ of viſion after its quieſcence, becauſe it is ſubject to more conſtant ſtimulus.

4. A certain quantity of ſtimulus leſs than natural induces the moving organ into feebler and more frequent contractions, as mentioned in No. I. 4. of this Section. For each contraction moving through a leſs ſpace, or with leſs force, that is, with leſs expenditure of the ſpirit of animation, is ſooner relaxed, and the ſpirit of animation derived

derived at each interval into the acting fibres being leſs, theſe intervals likewiſe become ſhorter. Hence the tremours of the hands of people accuſtomed to vinous ſpirit, till they take their uſual ſtimulus; hence the quick pulſe in fevers attended with ſtrength; in the latter the pulſe ſeldom beats above 120 times in a minute, in the former it frequently exceeds 140.

It muſt be obſerved, that in this and the two following articles the decreaſed action of the ſyſtem is probably more frequently occaſioned by deficiency in the quantity of ſenſorial power, than in the quantity of ſtimulus. Thus thoſe feeble conſtitutions which have large pupils of their eyes, and all who labour under nervous fevers, ſeem to owe their want of natural quantity of activity in the ſyſtem to the deficiency of ſenſorial power; ſince, as far as can be ſeen, they frequently poſſeſs the natural quantity of ſtimulus.

5. A certain quantity of ſtimulus, leſs than that above mentioned, inverts the order of ſucceſſive fibrous contractions; as in vomiting the vermicular motions of the ſtomach and duodenum are inverted, and their contents ejected, which is probably owing to the exhauſtion of the ſpirit of animation in the acting muſcles by a previous exceſſive ſtimulus, as by the root of ipecacuanha, and the conſequent defect of ſenſorial power. The ſame retrograde motions affect the whole inteſtinal canal in ileus; and the œſophagus in globus hyſtericus. See this further explained in Sect. XXIX. No. 11. on Retrograde Motions.

I muſt obſerve, alſo, that ſomething ſimilar happens in the production of our ideas, or ſenſual motions, when they are too weakly excited; when any one is thinking intenſely about one thing, and careleſsly converſing about another, he is liable to uſe the word of a contrary meaning to that

that which he deſigned, as cold weather for hot weather, ſummer for winter.

6. A certain quantity of ſtimulus, leſs than that above mentioned, is ſucceeded by paralyſis, firſt of the voluntary and ſenſitive motions, and afterwards of thoſe of irritation and of aſſociation, which conſtitutes death.

VI. *Cure of increaſed Exertion.*

1. The cure, which nature has provided for the increaſed exertion of any part of the ſyſtem, conſiſts in the conſequent expenditure of the ſenſorial power. But as a greater torpor follows this exhauſtion of ſenſorial power, as explained in the next paragraph, and a greater exertion ſucceeds this torpor, the conſtitution frequently ſinks under theſe increaſing librations between exertion and quieſcence; till at length complete quieſcence, that is, death, cloſes the ſcene.

For, during the great exertion of the ſyſtem in the hot fit of fever, an increaſe of ſtimulus is produced from the greater momentum of the blood, the greater diſtention of the heart and arteries, and the increaſed production of heat, by the violent actions of the ſyſtem occaſioned by this augmentation of ſtimulus, the ſenſorial power becomes diminiſhed in a few hours much beneath its natural quantity, the veſſels at length ceaſe to obey even theſe great degrees of ſtimulus, as ſhewn in Sect. XL. 9. 1. and a torpor of the whole or of a part of the ſyſtem enſues.

Now as this ſecond cold fit commences with a greater deficiency of ſenſorial power, it is alſo attended with a greater deficiency of ſtimulus than in the preceding cold fit, that is, with leſs momentum of blood, leſs diſtention of the heart. On this account the ſecond cold fit becomes more violent and

of

of longer duration than the firſt; and as a greater accumulation of ſenſorial power muſt be produced before the ſyſtem of veſſels will again obey the diminiſhed ſtimulus, it follows, that the ſecond hot fit of fever will be more violent than the former one. And that unleſs ſome other cauſes counteract either the violent exertions in the hot fit, or the great torpor in the cold fit, life will at length be extinguiſhed by the expenditure of the whole of the ſenſorial power. And from hence it appears, that the true means of curing fevers muſt be ſuch as decreaſe the action of the ſyſtem in the hot fit, and increaſe it in the cold fit; that is, ſuch as prevent the too great diminution of ſenſorial power in the hot fit, and the too great accumulation of it in the cold one.

2. Where the exertion of the ſenſorial powers is much increaſed, as in the hot fits of fever or inflammation, the following are the uſual means of relieving it. Decreaſe the irritations by bloodletting, and other evacuations; by cold water taken into the ſtomach, or injected as an enema, or uſed externally; by cold air breathed into the lungs, and diffuſed over the ſkin; with food of leſs ſtimulus than the patient has been accuſtomed to.

3. As a cold fit, or paroxyſm of inactivity of ſome parts of the ſyſtem, generally precedes the hot fit, or paroxyſm of exertion, by which the ſenſorial power becomes accumulated, this cold paroxyſm ſhould be prevented by ſtimulant medicines and diet, as wine, opium, bark, warmth, cheerfulneſs, anger, ſurpriſe.

4. Excite into greater action ſome other part of the ſyſtem, by which means the ſpirit of animation may be in part expended, and thence the inordinate actions of the diſeaſed part may be leſſened. Hence when a part of the ſkin acts violently, as of the face in the eruption of the ſmall pox, if the

feet

feet be cold they ſhould be covered. Hence the uſe of a bliſter applied near a topical inflammation. Hence opium and warm bath relieve pains both from exceſs and defect of ſtimulus.

5. Firſt increaſe the general ſtimulation above its natural quantity, which may in ſome degree exhauſt the ſpirit of animation, and then decreaſe the ſtimulation beneath its natural quantity. Hence after ſudorific medicines and warm air, the application of refrigerants may have greater effect, if they could be adminiſtered without danger of producing too great torpor of ſome part of the ſyſtem; as frequently happens to people in health from coming out of a warm room into the cold air, by which a topical inflammation in conſequence of torpor of the mucous membrane of the noſtril is produced, and is termed a cold in the head.

VII. *Cure of decreaſed Exertion.*

1. Where the exertion of the ſenſorial powers is much decreaſed, as in the cold fits of fever, a gradual accumulation of the ſpirit of animation takes place; as occurs in all caſes where inactivity or torpor of a part of the ſyſtem exiſts; this accumulation of ſenſorial power increaſes, till ſtimuli leſs than natural are ſufficient to throw it into action, then the cold fit ceaſes; and from the action of the natural ſtimuli a hot one ſucceeds with increaſed activity of the whole ſyſtem.

So in fainting fits, or ſyncope, there is a temporary deficiency of ſenſorial exertion, and a conſequent quieſcence of a great part of the ſyſtem. This quieſcence continues, till the ſenſorial power becomes again accumulated in the torpid organs; and then the uſual diurnal ſtimuli excite the reviviſcent parts again into action; but as this kind of quieſcence continues but a ſhort time compared

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to the cold paroxyſm of an ague, and leſs affects the circulatory ſyſtem, a leſs ſuperabundancy of exertion ſucceeds in the organs previouſly torpid, and a leſs exceſs of arterial activity. See Sect. XXXIV. 1. 6.

2. In the diſeaſes occaſioned by a defect of ſenſorial exertion, as in cold fits of ague, hyſteric complaint, and nervous fever, the following means are thoſe commonly uſed. 1. Increaſe the ſtimulation above its natural quantity for ſome weeks, till a new habit of more energetic contraction of the fibres is eſtabliſhed. This is to be done by wine, opium, bark, ſteel, given at exact periods, and in appropriate quantities; for if theſe medicines be given in ſuch quantity, as to induce the leaſt degree of intoxication, a debility ſucceeds from the uſeleſs exhauſtion of ſpirit of animation in conſequence of too great exertion of the muſcles or organs of ſenſe. To theſe irritative ſtimuli ſhould be added the ſenſitive ones of cheerful ideas, hope, affection.

3. Change the kinds of ſtimulus. The habits acquired by the conſtitution depend on ſuch nice circumſtances, that when one kind of ſtimulus ceaſes to excite the ſenſorial power into the quantity of exertion neceſſary to health, it is often ſufficient to change the ſtimulus for another apparently ſimilar in quantity and quality. Thus when wine ceaſes to ſtimulate the conſtitution, opium in appropriate doſes ſupplies the defect; and the contrary. This is alſo obſerved in the effects of cathartic medicines, when one loſes its power, another, apparently leſs efficacious, will ſucceed. Hence a change of diet, drink, and ſtimulating medicines, is often advantageous in diſeaſes of debility.

4. Stimulate the organs, whoſe motions are aſſociated with the torpid parts of the ſyſtem. The actions

actions of the minute veſſels of the various parts of the external ſkin are not only aſſociated with each other, but are ſtrongly aſſociated with thoſe of ſome of the internal membranes, and particularly of the ſtomach. Hence when the exertion of the ſtomach is leſs than natural, and indigeſtion and heart-burn ſucceed, nothing ſo certainly removes theſe ſymptoms as the ſtimulus of a bliſter on the back. The coldneſs of the extremities, as of the noſe, ears, or fingers, are hence the beſt indication for the ſucceſsful application of bliſters.

5. Decreaſe the ſtimulus for a time. By leſſening the quantity of heat for a minute or two by going into the cold bath, a great accumulation of ſenſorial power is produced; for not only the minute veſſels of the whole external ſkin for a time become inactive, as appears by their paleneſs; but the minute veſſels of the lungs loſe much of their activity alſo by concert with thoſe of the ſkin, as appears from the difficulty of breathing at firſt going into cold water. On emerging from the bath the ſenſorial power is thrown into great exertion by the ſtimulus of the common degree of the warmth of the atmoſphere, and a great production of animal heat is the conſequence. The longer a perſon continues in the cold bath the greater muſt be the preſent inertion of a great part of the ſyſtem, and in conſequence a greater accumulation of ſenſorial power. Whence M. Pomê recommends ſome melancholy patients to be kept from two to ſix hours in ſpring-water, and in baths ſtill colder.

6. Decreaſe the ſtimulus for a time below the natural, and then increaſe it above natural. The effect of this proceſs, improperly uſed, is ſeen in giving much food, or applying much warmth, to thoſe who have been previouſly expoſed to great hunger, or to great cold. The accumulated ſenſorial power

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is thrown into ſo violent exertion, that inflammations and mortifications ſupervene, and death cloſes the cataſtrophe. In many diſeaſes this method is the moſt ſucceſsful; hence the bark in agues produces more certain effect after the previous exhibition of emetics. In diſeaſes attended with violent pain, opium has double the effect, if veneſection and a cathartic have been previouſly uſed. On this ſeems to have been founded the ſucceſsful practice of Sydenham, who uſed veneſection and a cathartic in chloroſis before the exhibition of the bark, ſteel, and opiates.

7. Prevent any unneceſſary expenditure of ſenſorial power. Hence in fevers with debility, a decumbent poſture is preferred, with ſilence, little light, and ſuch a quantity of heat as may prevent any chill ſenſation, or any coldneſs of the extremities. The pulſe of patients in fevers with debility increaſes in frequency above ten pulſations in a minute on their riſing out of bed. For the expenditure of ſenſorial power to preſerve an erect poſture of the body adds to the general deficiency of it, and thus affects the circulation.

8. The longer in time and the greater in degree the quieſcence or inertion of an organ has been, ſo that it ſtill retains life or excitability, the leſs ſtimulus ſhould at firſt be applied to it. The quantity of ſtimulation is a matter of great nicety to determine, where the torpor or quieſcence of the fibres has been experienced in a great degree, or for a conſiderable time, as in cold fits of the ague, in continued fevers with great debility, or in people famiſhed at ſea, or periſhing with cold. In the two laſt caſes, very minute quantities of food ſhould be firſt ſupplied, and very few additional degrees of heat. In the two former caſes, but little ſtimulus of wine or medicine, above what they had been lately accuſtomed to, ſhould be exhibited, and

and this at frequent and ſtated intervals, ſo that the effect of one quantity may be obſerved before the exhibition of another.

If theſe circumſtances are not attended to, as the ſenſorial power becomes accumulated in the quieſcent fibres, an inordinate exertion takes place by the increaſe of ſtimulus acting on the accumulated quantity of ſenſorial power, and either the paralyſis, or death of the contractile fibres enſues, from the total expenditure of the ſenſorial power in the affected organ, owing to this increaſe of exertion, like the debility after intoxication. Or, ſecondly, the violent exertions above mentioned produce painful ſenſation, which becomes a new ſtimulus, and by thus producing inflammation, and increaſing the activity of the fibres already too great, ſooner exhauſts the whole of the ſenſorial power in the acting organ, and mortification, that is, the death of the part, ſupervenes.

Hence there have been many inſtances of people, whoſe limbs have been long benumbed by expoſure to cold, who have loſt them by mortification on their being too haſtily brought to the fire; and of others, who were nearly famiſhed at ſea, who have died ſoon after having taken not more than an uſual meal of food. I have heard of two well-atteſted inſtances of patients in the cold fit of ague, who have died from the exhibition of gin and vinegar, by the inflammation which enſued. And in many fevers attended with debility, the unlimited uſe of wine, and the wanton application of bliſters, I believe, has deſtroyed numbers by the debility conſequent to too great ſtimulation, that is, by the exhauſtion of the ſenſorial power by its inordinate exertion.

Wherever the leaſt degree of intoxication exiſts, a proportional debility is the conſequence; but there is a golden rule by which the neceſſary and uſeful

uſeful quantity of ſtimulus in fevers with debility may be aſcertained. When wine or beer are exhibited either alone or diluted with water, if the pulſe becomes ſlower the ſtimulus is of a proper quantity; and ſhould be repeated every two or three hours, or when the pulſe again becomes quicker.

In the chronical debility brought on by drinking ſpirituous or fermented liquors, there is another golden rule by which I have ſucceſsfully directed the quantity of ſpirit which they may ſafely leſſen, for there is no other means by which they can recover their health. It ſhould be premiſed, that where the power of digeſtion in theſe patients is totally deſtroyed, there is not much reaſon to expect a return to healthful vigour.

I have directed ſeveral of theſe patients to omit one fourth part of the quantity of vinous ſpirit they have been lately accuſtomed to, and if in a fortnight their appetite increaſes, they are adviſed to omit another fourth part; but if they perceive that their digeſtion becomes impaired from the want of this quantity of ſpirituous potation, they are adviſed to continue as they are, and rather bear the ills they have, than riſk the encounter of greater. At the ſame time fleſh-meat with or without ſpice is recommended, with Peruvian bark and ſteel in ſmall quantities between their meals, and half a grain of opium or a grain, with five or eight grains of rhubarb at night.

SECT.

SECT. XIII.

OF VEGETABLE ANIMATION.

I. 1. *Vegetables are irritable, mimoſa, dionæa muſcipula. Vegetable ſecretions.* 2. *Vegetable buds are inferior animals, are liable to greater or leſs irritability.* II. *Stamens and piſtils of plants ſhew marks of ſenſibility.* III. *Vegetables poſſeſs ſome degree of volition.* IV. *Motions of plants are aſſociated like thoſe of animals.* V. 1. *Vegetable ſtructure like that of animals, their anthers and ſtigmas are living creatures. Male-flowers of Vaiſneria.* 2. *Whether vegetables poſſeſs ideas? They have organs of ſenſe as of touch and ſmell, and ideas of external things?*

I. 1. The fibres of the vegetable world, as well as thoſe of the animal, are excitable into a variety of motion by irritations of external objects. This appears particularly in the mimoſa or ſenſitive plant, whoſe leaves contract on the ſlighteſt injury; the dionæa muſcipula, which was lately brought over from the marſhes of America, preſents us with another curious inſtance of vegetable irritability; its leaves are armed with ſpines on their upper edge, and are ſpread on the ground around the ſtem; when an inſect creeps on any of them in its paſſage to the flower or ſeed, the leaf ſhuts up like a ſteel rat-trap, and deſtroys its enemy. See Botanic Garden, Part II. note on Silene.

The various ſecretions of vegetables, as of odour, fruit, gum, reſin, wax, honey, ſeem brought about in the ſame manner as in the glands of animals; the taſteleſs moiſture of the earth is converted by the hop-plant into a bitter juice; as by the caterpillar

pillar in the nut-ſhell, the ſweet kernel is converted into a bitter powder. While the power of abſorption in the roots and barks of vegetables is excited into action by the fluids applied to their mouths like the lacteals and lymphatics of animals.

2. The individuals of the vegetable world may be conſidered as inferior or leſs perfect animals; a tree is a congeries of many living buds, and in this reſpect reſembles the branches of coralline, which are a congeries of a multitude of animals. Each of theſe buds of a tree has its proper leaves or petals for lungs, produces its viviparous or its oviparous offſpring in buds or ſeeds; has its own roots, which extending down the ſtem of the tree are interwoven with the roots of the other buds, and form the bark, which is the only living part of the ſtem, is annually renewed, and is ſuperinduced upon the former bark, which then dies, and with its ſtagnated juices gradually hardening into wood forms the concentric circles, which we ſee in blocks of timber.

The following circumſtances evince the individuality of the buds of trees. Firſt, there are many trees, whoſe whole internal wood is periſhed, and yet the branches are vegete and healthy. Secondly, the fibres of the barks of trees are chiefly longitudinal, reſembling roots, as is beautifully ſeen in thoſe prepared barks, that were lately brought from Otaheita. Thirdly, in horizontal wounds of the bark of trees, the fibres of the upper lip are always elongated downwards like roots, but thoſe of the lower lip do not approach to meet them. Fourthly, if you wrap wet moſs round any joint of a vine, or cover it with moiſt earth, roots will ſhoot out from it. Fifthly, by the inoculation or engrafting of trees many fruits are produced from one ſtem. Sixthly, a new tree is produced from a branch plucked from an old one, and ſet in the ground.

Whence it appears that the buds of deciduous trees are ſo many annual plants, that the bark is a contexture of the roots of each individual bud; and that the internal wood is of no other uſe but to ſupport them in the air, and that thus they reſemble the animal world in their individuality.

The irritability of plants, like that of animals, appears liable to be increaſed or decreaſed by habit; for thoſe trees or ſhrubs, which are brought from a colder climate to a warmer, put out their leaves and bloſſoms a fortnight ſooner than the indigenous ones.

Profeſſor Kalm, in his Travels in New York, obſerves that the apple-trees brought from England bloſſom a fortnight ſooner than the native ones. In our country the ſhrubs, that are brought a degree or two from the north, are obſerved to flouriſh better than thoſe, which come from the ſouth. The Siberian barley and cabbage are ſaid to grow larger in this climate than the ſimilar more ſouthern vegetables. And our hoards of roots, as of potatoes and onions, germinate with leſs heat in ſpring, after they have been accuſtomed to the winter's cold, than in autumn after the ſummer's heat.

II. The ſtamens and piſtils of flowers ſhew evident marks of ſenſibility, not only from many of the ſtamens and ſome piſtils approaching towards each other at the ſeaſon of impregnation, but from many of them cloſing their petals and calyxes during the cold parts of the day. For this cannot be aſcribed to irritation, becauſe cold means a defect of the ſtimulus of heat; but as the want of accuſtomed ſtimuli produces pain, as in coldneſs, hunger, and thirſt of animals, theſe motions of vegetables in cloſing up their flowers muſt be aſcribed to the diſagreeable ſenſation, and not to the irritation of cold. Others cloſe up their leaves during darkneſs, which,

like

like the former, cannot be owing to irritation, as the irritating material is withdrawn.

The approach of the anthers in many flowers to the ſtigmas, and of the piſtils of ſome flowers to the anthers, muſt be aſcribed to the paſſion of love, and hence belongs to ſenſation, not to irritation.

III. That the vegetable world poſſeſſes ſome degree of voluntary powers, appears from their neceſſity to ſleep, which we have ſhewn in Sect. XVIII. to conſiſt in the temporary abolition of voluntary power. This voluntary power ſeems to be exerted in the circular movement of the tendrils of vines, and other climbing vegetables; or in the efforts to turn the upper ſurface of their leaves, or their flowers to the light.

IV. The aſſociations of fibrous motions are obſervable in the vegetable world, as well as in the animal. The diviſions of the leaves of the ſenſitive plant have been accuſtomed to contract at the ſame time from the abſence of light; hence if by any other circumſtance, as a ſlight ſtroke or injury, one diviſion is irritated into contraction, the neighbouring ones contract alſo, from their motions being aſſociated with thoſe of the irritated part. So the various ſtamina of the claſs of ſyngeneſia have been accuſtomed to contract together in the evening, and thence if you ſtimulate one of them with a pin, according to the experiment of M. Colvolo, they all contract from their acquired aſſociations.

To evince that the collapſing of the ſenſitive plant is not owing to any mechanical vibrations propagated along the whole branch, when a ſingle leaf is ſtruck with the finger, a leaf of it was ſlit with ſharp ſciſſors, and ſome ſeconds of time paſſed before the plant ſeemed ſenſible of the injury; and then the whole branch collapſed as far as the prin-

cipal ſtem: this experiment was repeated ſeveral times with the leaſt poſſible impulſe to the plant.

V. 1. For the numerous circumſtances in which vegetable buds are analogous to animals, the reader is referred to the additional notes at the end of the Botanic Garden, Part I. It is there ſhewn, that the roots of vegetables reſemble the lacteal ſyſtem of animals; the ſap-veſſels in the early ſpring, before their leaves expand, are analogous to the placental veſſels of the fœtus; that the leaves of land-plants reſemble lungs, and thoſe of aquatic plants the gills of fiſh; that there are other ſyſtems of veſſels reſembling the vena portarum of quadrupeds, or the aorta of fiſh; that the digeſtive power of vegetables is ſimilar to that of animals converting the fluids, which they abſorb, into ſugar; that their ſeeds reſemble the eggs of animals, and their buds and bulbs their viviparous offſpring. And, laſtly, that the anthers and ſtigmas are real animals, attached indeed to their parent tree like polypi or coral inſects, but capable of ſpontaneous motion: that they are affected with the paſſion of love, and furniſhed with powers of reproducing their ſpecies, and are fed with honey like the moths and butterflies, which plunder their nectaries. See Botanic Garden, Part I. add. note XXXIX.

The male flowers of valliſneria approach ſtill nearer to apparent animality, as they detach themſelves from the parent plant, and float on the ſurface of the water to the female ones. Botanic Garden, Part II. Art. Valliſneria. Other flowers of the claſſes of monecia and diecia, and polygamia, diſcharge the fecundating farina, which floating in the air is carried to the ſtigma of the female flowers, and that at conſiderable diſtances. Can this be effected by any ſpecific attraction? or, like the diffuſion of the odorous particles of flowers, is it left to the currents of winds, and the accidental miſcarriages

miſcarriages of it counteracted by the quantity of its production?

2. This leads us to a curious enquiry, whether vegetables have ideas of external things? As all our ideas are originally received by our ſenſes, the queſtion may be changed to, whether vegetables poſſeſs any organs of ſenſe? Certain it is, that they poſſeſs a ſenſe of heat and cold, another of moiſture and dryneſs, and another of light and darkneſs; for they cloſe their petals occaſionally from the preſence of cold, moiſture, or darkneſs. And it has been already ſhewn, that theſe actions cannot be performed ſimply from irritation, becauſe cold and darkneſs are negative quantities, and on that account ſenſation or volition are implied; and in conſequence a ſenſorium or union of their nerves. So when we go into the light, we contract the iris; not from any ſtimulus of the light on the fine muſcles of the iris; but from its motions being aſſociated with the ſenſation of too much light on the retina: which could not take place without a ſenſorium or center of union of the nerves of the iris with thoſe of viſion. See Botanic Garden, Part I, Canto 3. l. 440. note.

Beſides theſe organs of ſenſe, which diſtinguiſh cold, moiſture, and darkneſs, the leaves of mimoſa, and of dionæa, and of droſera, and the ſtamens of many flowers, as of the berbery, and the numerous claſs of ſyngeneſia, are ſenſible to mechanic impact, that is, they poſſeſs a ſenſe of touch, as well as a common ſenſorium; by the medium of which their muſcles are excited into action. Laſtly, in many flowers the anthers, when mature, approach the ſtigma, in others the female organ approaches to the male. In a plant of collinſonia, a branch of which is now before me, the two yellow ſtamens are about three eighths of an inch high, and diverge from each other, at an angle of about fifteen

fifteen degrees, the purple ſtyle is half an inch high, and in ſome flowers is now applied to the ſtamen on the right hand, and in others to that of the left; and will, I ſuppoſe, change place to-morrow in thoſe, where the anthers have not yet effuſed their powder.

I aſk, by what means are the anthers in many flowers, and ſtigmas in other flowers, directed to find their paramours? How do either of them know, that the other exiſts in their vicinity? Is this curious kind of ſtorge produced by mechanic attraction, or by the ſenſation of love? The latter opinion is ſupported by the ſtrongeſt analogy, becauſe a reproduction of the ſpecies is the conſequence; and then another organ of ſenſe muſt be wanted to direct theſe vegetable amourettes to find each other, one probably analogous to our ſenſe of ſmell, which in the animal world directs the new-born infant to its ſource of nouriſhment, and they may thus poſſeſs a faculty of perceiving as well as of producing odours.

Thus, beſides a kind of taſte at the extremities of their roots, ſimilar to that of the extremities of our lacteal veſſels, for the purpoſe of ſelecting their proper food: and beſides different kinds of irritability reſiding in the various glands, which ſeparate honey, wax, reſin, and other juices from their blood; vegetable life ſeems to poſſeſs an organ of ſenſe to diſtinguiſh the variations of heat, another to diſtinguiſh the varying degrees of moiſture, another of light, another of touch, and probably another analogous to our ſenſe of ſmell. To theſe muſt be added the indubitable evidence of their paſſion of love, and I think we may truly conclude, that they are furniſhed with a common ſenſorium belonging to each bud, and that they muſt occaſionally repeat thoſe perceptions either in their dreams

or

or waking hours, and consequently possess ideas of so many of the properties of the external world, and of their own existence.

SECT. XIV.

OF THE PRODUCTION OF IDEAS.

I. *Of material and immaterial beings. Doctrine of St. Paul.* II. 1. *Of the sense of touch. Of solidity.* 2. *Of figure. Motion. Time. Place. Space. Number.* 3. *Of the penetrability of matter.* 4. *Spirit of animation possesses solidity, figure, visibility, &c. Of spirits and angels.* 5. *The existence of external things.* III. *Of vision.* IV. *Of hearing.* V. *Of smell and taste.* VI. *Of the organ of sense by which we perceive heat and cold, not by the sense of touch.* VII. *Of the sense of extension, the whole of the locomotive muscles may be considered as one organ of sense.* VIII. *Of the senses of hunger, thirst, want of fresh air, suckling children, and lust.* IX. *Of many other organs of sense belonging to the glands. Of painful sensations from the excess of light, pressure, heat, itching, caustics, and electricity.*

I. PHILOSOPHERS have been much perplexed to understand, in what manner we become acquainted with the external world; insomuch that Dr. Berkley even doubted its existence, from having observed (as he thought) that none of our ideas resemble their correspondent objects. Mr. Hume asserts, that our belief depends on the greater distinctness

tinctneſs or energy of our ideas from perception; and Mr. Reid has lately contended, that our belief of external objects is an innate principle neceſſarily joined with our perceptions.

So true is the obſervation of the famous Malbranch, "that our ſenſes are not given us to diſcover the eſſences of things, but to acquaint us with the means of preſerving our exiſtence," (L. I. ch. v.) a melancholy reflection to philoſophers!

Some philoſophers have divided all created beings into material and immaterial: the former including all that part of being, which obeys the mechanic laws of action and reaction, but which can begin no motion of itſelf; the other is the cauſe of all motion, and is either termed the power of gravity, or of ſpecific attraction, or the ſpirit of animation. This immaterial agent is ſuppoſed to exiſt in or with matter, but to be quite diſtinct from it, and to be equally capable of exiſtence, after the matter, which now poſſeſſes it, is decompoſed.

Nor is this theory ill ſupported by analogy, ſince heat, electricity, and magnetiſm, can be given to or taken from a piece of iron; and muſt therefore exiſt, whether ſeparated from the metal, or combined with it. From a parity of reaſoning, the ſpirit of animation would appear to be capable of exiſting as well ſeparately from the body as with it.

I beg to be underſtood, that I do not wiſh to diſpute about words, and am ready to allow, that the powers of gravity, ſpecific attraction, electricity, magnetiſm, and even the ſpirit of animation, may conſiſt of matter of a finer kind; and to believe, with St. Paul and Malbranch, that the ultimate cauſe only of all motion is immaterial, that is God. St. Paul ſays, "in him we live and move, and have our being;" and in the 15th chapter to

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the Corinthians, diſtinguiſhes between the pſyche or living ſpirit, and the pneuma or reviving ſpirit. By the words ſpirit of animation or ſenſorial power, I mean only that animal life, which mankind poſſeſſes in common with brutes, and in ſome degree even with vegetables, and leave the conſideration of the immortal part of us, which is the object of religion, to thoſe who treat of revelation.

II. 1. *Of the Senſe of Touch.*

The firſt idea we become acquainted with, are thoſe of the ſenſe of touch; for the fœtus muſt experience ſome varieties of agitation, and exert ſome muſcular action, in the womb; and may with great probability be ſuppoſed thus to gain ſome ideas of its own figure, of that of the uterus, and of the tenacity of the fluid, that ſurrounds it, (as appears from the facts mentioned in the ſucceeding Section upon Inſtinct.)

Many of the organs of ſenſe are confined to a ſmall part of the body, as the noſtrils, ear, or eye, whilſt the ſenſe of touch is diffuſed over the whole ſkin, but exiſts with a more exquiſite degree of delicacy at the extremities of the fingers and thumbs, and in the lips. The ſenſe of touch is thus very commodiouſly diſpoſed for the purpoſe of encompaſſing ſmaller bodies, and for adapting itſelf to the inequalities of larger ones. The figure of ſmall bodies ſeems to be learnt by children by their lips as much as by their fingers; on which account they put every new object to their mouths, when they are ſatiated with food, as well as when they are hungry. And puppies ſeem to learn their ideas of figure principally by the lips in their mode of play.

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We acquire our tangible ideas of objects either by the ſimple preſſure of this organ of touch againſt a ſolid body, or by moving our organ of touch along the ſurface of it. In the former caſe we learn the length and breadth of the object by the quantity of our organ of touch, that is impreſſed by it: in the latter caſe we learn the length and breadth of objects by the continuance of their preſſure on our moving organ of touch.

It is hence, that we are very ſlow in acquiring our tangible ideas, and very ſlow in recollecting them; for if I now think of the tangible idea of a cube, that is, if I think of its figure, and of the ſolidity of every part of that figure, I muſt conceive myſelf as paſſing my fingers over it, and ſeem in ſome meaſure to feel the idea, as I formerly did the impreſſion, at the ends of them, and am thus very ſlow in diſtinctly recollecting it.

When a body compreſſes any part of our ſenſe of touch, what happens? Firſt, this part of our ſenſorium undergoes a mechanical compreſſion, which is termed a ſtimulus; ſecondly, an idea, or contraction of a part of the organ of ſenſe is excited; thirdly, a motion of the central parts, or of the whole ſenſorium, which is termed ſenſation, is produced; and theſe three conſtitute the perception of ſolidity.

2. *Of Figure, Motion, Time, Place, Space, Number.*

No one will deny, that the medulla of the brain and nerves has a certain figure; which, as it is diffuſed through nearly the whole of the body, muſt have nearly the figure of that body. Now it follows, that the ſpirit of animation, or living principle, as it occupies this medulla, and no other part, (which is evinced by a great variety of cruel experiments on living animals,) it follows, that this

this ſpirit of animation has alſo the ſame figure as the medulla above deſcribed. I appeal to common ſenſe! the ſpirit of animation acts, Where does it act? It acts wherever there is the medulla above mentioned; and that whether the limb is yet joined to a living animal, or whether it be recently detached from it; as the heart of a viper or frog will renew its contractions, when pricked with a pin, for many minutes of time after its exſection from the body.—Does it act any where elſe?—No; then it certainly exiſts in this part of ſpace, and no where elſe; that is, it hath figure; namely, the figure of the nervous ſyſtem, which is nearly the figure of the body. When the idea of ſolidity is excited, as above explained, a part of the extenſive organ of touch is compreſſed by ſome external body, and this part of the ſenſorium ſo compreſſed exactly reſembles *in figure* the figure of the body that compreſſed it. Hence, when we acquire the idea of ſolidity, we acquire at the ſame time the idea of FIGURE; and this idea of figure, or motion of *a part* of the organ of touch, exactly reſembles *in its figure* the figure of the body that occaſions it; and thus exactly acquaints us with this property of the external world.

Now, as the whole univerſe with all its parts poſſeſſes a certain form or figure, if any part of it moves, that form or figure of the whole is varied: hence, as MOTION is no other than a perpetual variation of figure, our idea of motion is alſo a real reſemblance of the motion that produced it.

It may be ſaid in objection to this definition of motion, that an ivory globe may revolve on its axis, and that here will be a motion without change of figure. But the figure of the particle x on one ſide of this globe is not the *ſame* figure as the figure of y on the other ſide, any more than the particles themſelves are the ſame, though they are *ſimilar* figures;

figures; and hence they cannot change place with each other without disturbing or changing the figure of the whole.

Our idea of TIME is from the same source, but is more abstracted, as it includes only the comparative velocities of these variations of figure; hence if it be asked, How long was this book in printing? it may be answered, Whilst the sun was passing through Aries.

Our idea of PLACE includes only the figure of a group of bodies, not the figures of the bodies themselves. If it be asked, where is Nottinghamshire, the answer is, it is surrounded by Derbyshire, Lincolnshire, and Leicestershire; hence place is our idea of the figure of one body surrounded by the figures of other bodies.

The idea of SPACE is a more abstracted idea of place excluding the group of bodies.

The idea of NUMBER includes only the particular arrangements, or distributions of a group of bodies, and is therefore only a more abstracted idea of the parts of the figure of the group of bodies; thus when I say England is divided into forty counties, I only speak of certain divisions of its figure.

Hence arises the certainty of the mathematical sciences, as they explain these properties of bodies, which are exactly resembled by our ideas of them, whilst we are obliged to collect almost all our other knowledge from experiment; that is, by observing the effects exerted by one body upon another.

3. *Of the Penetrability of Matter.*

The impossibility of two bodies existing together in the same space cannot be deduced from our idea of solidity, or of figure. As soon as we perceive the motions of objects that surround us, and learn that

that we poſſeſs a power to move our own bodies, we experience, that thoſe objects, which excite in us the idea of ſolidity and of figure, oppoſe this voluntary movement of our own organs; as whilſt I endeavour to compreſs between my hands an ivory ball into a ſpheroid. And we are hence taught by experience, that our own body, and thoſe which we touch, cannot exiſt in the ſame part of ſpace.

But this by no means demonſtrates, that no two bodies can exiſt together in the ſame part of ſpace. Galilæo in the preface to his works ſeems to be of opinion, that matter is not impenetrable; Mr. Michel, and Mr. Boſcowich in his Theoria Philoſ. Natur. have eſpouſed this hypotheſis; which has been lately publiſhed by Dr. Prieſtley, to whom the world is much indebted for ſo many important diſcoveries in ſcience. (Hiſt. of Light and Colours, p. 391.) The uninterrupted paſſage of light through tranſparent bodies, of the electric æther through metallic and aqueous bodies, and of the magnetic effluvia through all bodies, would ſeem to give ſome probability to this opinion. Hence it appears, that beings may exiſt without poſſeſſing the property of ſolidity, as well as they can exiſt without poſſeſſing the properties, which excite our ſmell or taſte, and can thence occupy ſpace without detruding other bodies from it; but we cannot become acquainted with ſuch beings by our ſenſe of touch, any more than we can with odours or flavours without our ſenſes of ſmell and taſte.

But that any being can exiſt without exiſting in ſpace, is to my ideas utterly incomprehenſible. My appeal is to common ſenſe. *To be* implies a when and a where; the one is comparing it with the motions of other beings, and the other with their ſituations.

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If there was but one object, as the whole creation may be considered as one object, then I cannot ask where it exists? for there are no other objects to compare its situation with. Hence if any one denies, that a being exists in space, he denies, that there are any other beings but that one; for to answer the question, "Where does it exist?" is only to mention the situation of the objects that surround it.

In the same manner if it be asked—"When does a being exist?" The answer only specifies the successive motions either of itself, or of other bodies; hence to say, a body exists not in time, is to say, that there is, or was, no motion in the world.

4. *Of the Spirit of Animation.*

But though there may exist beings in the universe, that have not the property of solidity; that is, which can possess any part of space, at the same time that it is occupied by other bodies; yet there may be other beings, that can assume this property of solidity, or disrobe themselves of it occasionally, as we are taught of spirits, and of angels; and it would seem, that THE SPIRIT OF ANIMATION must be endued with this property, otherwise how could it occasionally give motion to the limbs of animals? —or be itself stimulated into motion by the obtrusions of surrounding bodies, as of light, or odour?

If the spirit of animation was always necessarily penetrable, it could not influence or be influenced by the solidity of common matter; they would exist together, but could not detrude each other from the part of space, where they exist; that is, they could not communicate motion to each other. *No two things can influence or affect each other, which have not some property common to both of them;* for to influence or affect another body is to give or communicate

municate ſome property to it, that it had not before; but how can one body give that to another, which it does not poſſeſs itſelf?—The words imply, that they muſt agree in having the power or faculty of poſſeſſing ſome common property. Thus if one body removes another from the part of ſpace, that it poſſeſſes, it muſt have the power of occupying that ſpace itſelf: and if one body communicates heat or motion to another, it follows, that they have alike the property of poſſeſſing heat, or motion.

Hence the ſpirit of animation at the time it communicates or receives motion from ſolid bodies, muſt itſelf poſſeſs ſome property of ſolidity. And in conſequence at the time it receives other kinds of motion from light, it muſt poſſeſs that property, which light poſſeſſes, to communicate that kind of motion; and for which no language has a name, unleſs it may be termed Viſibility. And at the time it is ſtimulated into other kinds of animal motion by the particles of ſapid and odorous bodies affecting the ſenſes of taſte and ſmell, it muſt reſemble theſe particles of flavour, and of odour, in poſſeſſing ſome ſimilar or correſpondent property; and for which language has no name, unleſs we may uſe the words Saporoſity and Odoroſity for thoſe common properties, which are poſſeſſed by our organs of taſte and ſmell, and by the particles of ſapid and odorous bodies; as the words Tangibility and Audibility may expreſs the common property poſſeſſed by our organs of touch, and of hearing, and by the ſolid bodies, or their vibrations, which affect thoſe organs.

5. Finally, though the figures of bodies are in truth reſembled by the figure of the part of the organ of touch, which is ſtimulated into motion; and that organ reſembles the ſolid body, which ſtimulates it, in its property of ſolidity; and though the

the ſenſe of hearing reſembles the vibrations of external bodies in its capability of being ſtimulated into motion by thoſe vibrations; and though our other organs of ſenſe reſemble the bodies, that ſtimulate them, in their capability of being ſtimulated by them; and we hence become acquainted with theſe properties of the external world; yet as we can repeat all theſe motions of our organs of ſenſe by the efforts of volition, or in conſequence of the ſenſation of pleaſure or pain, or by their aſſociation with other fibrous motions, as happens in our reveries or in ſleep, there would ſtill appear to be ſome difficulty in demonſtrating the exiſtence of any thing external to us.

In our dreams we cannot determine this circumſtance, becauſe our power of volition is ſuſpended, and the ſtimuli of external objectss are excluded; but in our waking hours we can compare our ideas belonging to one ſenſe with thoſe belonging to another, and can thus diſtinguiſh the ideas occaſioned by irritation from thoſe excited by ſenſation, volition, or aſſociation. Thus if the idea of the ſweetneſs of ſugar ſhould be excited in our dreams, the whiteneſs and hardneſs of it occur at the ſame time by aſſociation; and we believe a material lump of ſugar preſent before us. But if, in our waking hours, the idea of the ſweetneſs of ſugar occurs to us, the ſtimuli of ſurrounding objects, as the edge of the table, on which we preſs, or green colour of the graſs, on which we tread, prevent the other ideas of the hardneſs and whiteneſs of the ſugar from being exerted by aſſociation. Or if they ſhould occur, we voluntarily compare them with the irritative ideas of the table or graſs above mentioned, and detect their fallacy. We can thus diſtinguiſh the ideas cauſed by the ſtimuli of external objects from thoſe, which are introduced by aſſociation, ſenſation, or volition; and during

during our waking hours can thus acquire a knowledge of the external world. Which nevertheleſs we cannot do in our dreams, becauſe we have neither perceptions of external bodies, nor the power of volition to enable us to compare them with the ideas of imagination.

III. *Of Viſion.*

OUR eyes obſerve a difference of colour, or of ſhade, in the prominences and depreſſions of objects, and that thoſe ſhades uniformly vary, when the ſenſe of touch obſerves any variation. Hence when the retina becomes ſtimulated by colours or ſhades of light in a certain form, as in a circular ſpot; we know by experience, that this is a ſign, that a tangible body is before us; and that its figure is reſembled by the miniature figure of the part of the organ of viſion, that is thus ſtimulated.

Here whilſt the ſtimulated part of the retina reſembles exactly the viſible figure of the whole in miniature, the various kinds of ſtimuli from different colours mark the viſible figures of the minuter parts; and by habit we inſtantly recall the tangible figures.

Thus when a tree is the object of ſight, a part of the retina reſembling a flat branching figure is ſtimulated by various ſhades of colours; but it is by ſuggeſtion, that the gibboſity of the tree, and the moſs, that fringes its trunk, appear before us. Theſe are ideas of ſuggeſtion, which we feel or attend to, aſſociated with the motions of the retina, or irritative ideas, which we do not attend to.

So that though our viſible ideas reſemble in miniature the outline of the figure of coloured bodies, in other reſpects they ſerve only as a language,

which by acquired aſſociations introduce the tangible ideas of bodies. Hence it is, that this ſenſe is ſo readily deceived by the art of the painter to our amuſement and inſtruction. The reader will find much very curious knowledge on this ſubject in Biſhop Berkley's Eſſay on Viſion, a work of great ingenuity.

The immediate object however of the ſenſe of viſion is light; this fluid, though its velocity is ſo great, appears to have no perceptible mechanical impulſe, as was mentioned in the third Section, but ſeems to ſtimulate the retina into animal motion by its tranſmiſſion through this part of the ſenſorium: for though the eyes of cats or other animals appear luminous in obſcure places; yet it is probable, that none of the light, which falls on the retina, is reflected from it, but adheres to or enters into combination with the choroide coat behind it.

The combination of the particles of light with opake bodies, and therefore with the choroide coat of the eye, is evinced from the heat, which is given out, as in other chemical combinations. For the ſun-beams communicate no heat in their paſſage through tranſparent bodies, with which they do not combine, as the air continues cool even in the focus of the largeſt burning-glaſſes, which in a moment vitrifies a particle of opaque matter.

IV. *Of the Organ of Hearing.*

It is generally believed, that the tympanum of the ear vibrates mechanically, when expoſed to audible ſounds, like the ſtrings of one muſical inſtrument, when the ſame notes are ſtruck upon another. Nor is this opinion improbable, as the muſcles and cartilages of the larynx are employed in producing variety of tones by mechanical vibration:

tion: ſo the muſcles and bones of the ear ſeem adapted to increaſe or diminiſh the tenſion of the tympanum for the purpoſes of ſimilar mechanical vibrations.

But it appears from diſſection, that the tympanum is not the immediate organ of hearing, but that like the humours and cornea of the eye, it is only of uſe to prepare the object for the immediate organ. For the portio mollis of the auditory nerve is not ſpread upon the tympanum, but upon the veſtibulum, and cochlea, and ſemicircular canals of the ear; while between the tympanum and the expanſion of the auditory nerve the cavity is ſaid by Dr. Cotunnus and Dr. Meckel to be filled with water; as they had frequently obſerved by freezing the heads of dead animals before they diſſected them; and water being a more denſe fluid than air is much better adapted to the propagation of vibrations. We may add, that even the external opening of the ear is not abſolutely neceſſary for the perception of ſound: for ſome people, who from theſe defects would have been completely deaf, have diſtinguiſhed acute or grave ſounds by the tremours of a ſtick held between their teeth propagated along the bones of the head, (Haller. Phyſ. T. V. p. 295).

Hence it appears, that the immediate organ of hearing is not affected by the particles of the air themſelves, but is ſtimulated into animal motion by the vibrations of them. And it is probable from the looſe bones, which are found in the heads of ſome fiſhes, that the vibrations of water are ſenſible to the inhabitants of that element by a ſimilar organ.

The motions of the atmoſphere, which we become acquainted with by the ſenſe of touch, are combined with its ſolidity, weight, or vis inertiæ; whereas thoſe, that are perceived by this organ,

depend alone on its elaſticity. But though the vibration of the air is the immediate object of the ſenſe of hearing, yet the ideas, we receive by this ſenſe, like thoſe received from light, are only as a language, which by acquired aſſociations acquaints us with thoſe motions of tangible bodies, which depend on their elaſticity; and which we had before learned by our ſenſe of touch.

V. *Of Smell and of Taſte.*

The objects of ſmell are diſſolved in the fluid atmoſphere, and thoſe of taſte in the ſaliva, or other aqueous fluid, for the better diffuſing them on their reſpective organs, which ſeem to be ſtimulated into animal motion perhaps by the chemical affinities of theſe particles, which conſtitute the ſapidity and odoroſity of bodies with the nerves of ſenſe, which perceive them.

Mr. Volta has lately obſerved a curious circumſtance relative to our ſenſe of taſte. If a bit of clean lead and a bit of clean ſilver be ſeparately applied to the tongue and palate no taſte is perceived; but by applying them in contact in reſpect to the parts out of the mouth, and nearly ſo in reſpect to the parts, which are immediately applied to the tongue and palate, a ſaline or acidulous taſte is perceived, as of a fluid like a ſtream of electricity paſſing from one of them to the other. This new application of the ſenſe of taſte deſerves further inveſtigation, as it may acquaint us with new properties of matter.

From the experiments above mentioned of Galvani, Volta, Fowler, and others, it appears, that a plate of zinc and a plate of ſilver have greater effect than lead and ſilver. If one edge of a plate of ſilver about the ſize of half a crown-piece be placed upon the tongue, and one edge of a plate of zinc about the ſame ſize beneath the tongue, and

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if their oppoſite edges are then brought into contact before the point of the tongue, a taſte is perceived at the moment of their coming into contact; ſecondly, if one of the above plates be put between the upper lip and the gum of the fore-teeth, and the other be placed under the tongue, and their exterior edges be then brought into contact in a darkiſh room, a flaſh of light is perceived in the eyes.

Theſe effects I imagine only ſhew the ſenſibility of our nerves of ſenſe to very ſmall quantities of the electric fluid, as it paſſes through them; for I ſuppoſe theſe ſenſations are occaſioned by ſlight electric ſhocks produced in the following manner. By the experiments publiſhed by Mr. Bennet, with his ingenious doubler of electricity, which is the greateſt diſcovery made in that ſcience ſince the coated jar, and the eduction of lightning from the ſkies, it appears that zinc was always found minus, and ſilver was always found plus, when both of them were in their ſeparate ſtate. Hence, when they are placed in the manner above deſcribed, as ſoon as their exterior edges come nearly into contact, ſo near as to have an extremely thin plate of air between them, that plate of air becomes charged in the ſame manner as a plate of coated glaſs; and is at the ſame inſtant diſcharged through the nerves of taſte or of ſight, and gives the ſenſations, as above deſcribed, of light or of ſaporoſity; and only ſhews the great ſenſibility of theſe organs of ſenſe to the ſtimulus of the electric fluid in ſuddenly paſſing through them.

VI. *Of the Senſe of Heat.*

THERE are many experiments in chemical writers, that evince the exiſtence of heat as a fluid element, which covers and pervades all bodies, and

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is attracted by the ſolutions of ſome of them, and is detruded from the combination of others. Thus from the combinations of metals with acids, and from thoſe combinations of animal fluids, which are termed ſecretions, this fluid matter of heat is given out amongſt the neighbouring bodies; and in the ſolutions of ſalts in water, or of water in air, it is abſorbed from the bodies, that ſurround them; whilſt in its facility in paſſing through metallic bodies, and its difficulty in pervading reſins and glaſs, it reſembles the properties of the electric aura; and is like that excited by friction, and ſeems like that to gravitate amongſt other bodies in its uncombined ſtate, and to find its equilibrium.

There is no circumſtance of more conſequence in the animal economy than a due proportion of this fluid of heat; for the digeſtion of our nutriment in the ſtomach and bowels, and the proper qualities of all our ſecreted fluids, as they are produced or prepared partly by animal and partly by chemical proceſſes, depend much on the quantity of heat; the exceſs of which, or its deficiency, alike gives us pain, and induces us to avoid the circumſtances that occaſion them. And in this the perception of heat eſſentially differs from the perceptions of the ſenſe of touch, as we receive pain from too great preſſure of ſolid bodies, but none from the abſence of it. It is hence probable, that nature has provided us with a ſet of nerves for the perception of this fluid, which anatomiſts have not yet attended to.

There may be ſome difficulty in the proof of this aſſertion; if we look at a hot fire, we experience no pain of the optic nerve, though the heat along with the light muſt be concentrated upon it. Nor does warm water or warm oil poured into the ear give pain to the organ of hearing; and hence as

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theſe organs of ſenſe do not perceive ſmall exceſſes or deficiencies of heat; and as heat has no greater analogy to the ſolidity or to the figures of bodies, than it has to their colours or vibrations; there ſeems no ſufficient reaſon for our aſcribing the perception of heat and cold to the ſenſe of touch; to which it has generally been attributed, either becauſe it is diffuſed beneath the whole ſkin like the ſenſe of touch, or owing to the inaccuracy of our obſervations, or the defect of our languages.

There is another circumſtance would induce us to believe, that the perceptions of heat and cold do not belong to the organ of touch; ſince the teeth, which are the leaſt adapted for the perceptions of ſolidity or figure, are the moſt ſenſible to heat or cold; whence we are forewarned from ſwallowing thoſe materials, whoſe degree of coldneſs or of heat would injure our ſtomachs.

The following is an extract from a letter of Dr. R. W. Darwin, of Shrewſbury, when he was a ſtudent at Edinburgh. "I made an experiment yeſterday in our hoſpital, which much favours your opinion, that the ſenſation of heat and of touch depend on different ſets of nerves. A man who had lately recovered from a fever, and was ſtill weak, was ſeized with violent cramps in his legs and feet; which were removed by opiates, except that one of his feet remained inſenſible. Mr. Ewart pricked him with a pin in five or ſix places, and the patient declared he did not feel it in the leaſt, nor was he ſenſible of a very ſmart pinch. I then held a red-hot poker at ſome diſtance, and brought it gradually nearer till it came within three inches, when he aſſerted that he felt it quite diſtinctly. I ſuppoſe ſome violent irritation on the nerves of touch had cauſed the cramps, and had left them paralytic; while the nerves of heat, having ſuffered no increaſed ſtimulus, retained their irritability."

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Add to this, that the lungs, though eaſily ſtimulated into inflammation, are not ſenſible to heat. See Claſs, III. 1. 1. 10.

VII. *Of the Senſe of Extenſion.*

The organ of touch is properly the ſenſe of preſſure, but the muſcular fibres themſelves conſtitute the organ of ſenſe, that feels extenſion. The ſenſe of preſſure is always attended with the ideas of the figure and ſolidity of the object, neither of which accompany our perception of extenſion. The whole ſet of muſcles, whether they are hollow ones, as the heart, arteries, and inteſtines, or longitudinal ones attached to bones, contract themſelves, whenever they are ſtimulated by forcible elongation; and it is obſervable, that the white muſcles, which conſtitute the arterial ſyſtem, ſeem to be excited into contraction from no other kinds of ſtimulus, according to the experiments of Haller. And hence the violent pain in ſome inflammations, as in the paronychia, obtains immediate relief by cutting the membrane, that was ſtretched by the tumour of the ſubjacent parts.

Hence the whole muſcular ſyſtem may be conſidered as one organ of ſenſe, and the various attitudes of the body, as ideas belonging to this organ, of many of which we are hourly conſcious, while many others, like the irritative ideas of the other ſenſes, are performed without our attention.

When the muſcles of the heart ceaſe to act, the refluent blood again diſtends or elongates them; and thus irritated they contract as before. The ſame happens to the arterial ſyſtem, and I ſuppoſe to the capillaries, inteſtines, and various glands of the body.

When the quantity of urine, or of excrement, diſtends the bladder, or rectum, thoſe parts contract,

tract, and exclude their contents, and many other muſcles by aſſociation act along with them; but if theſe evacuations are not ſoon complied with, pain is produced by a little further extenſion of the muſcular fibres: a ſimilar pain is cauſed in the muſcles, when a limb is much extended for the reduction of diſlocated bones; and in the puniſhment of the rack: and in the painful cramps of the calf of the leg, or of other muſcles, for a greater degree of contraction of a muſcle, than the movement of the two bones, to which its ends are affixed, will admit of, muſt give ſimilar pain to that, which is produced by extending it beyond its due length. And the pain from punctures or inciſions ariſes from the diſtention of the fibres, as the knife paſſes through them; for it nearly ceaſes as ſoon as the diviſion is completed.

All theſe motions of the muſcles, that are thus naturally excited by the ſtimulus of diſtending bodies, are alſo liable to be called into ſtrong action by their catenation, with the irritations or ſenſations produced by the momentum of the progreſſive particles of blood in the arteries, as in inflammatory fevers, or by acrid ſubſtances on other ſenſible organs, as in the ſtrangury, or teneſmus, or cholera.

We ſhall conclude this account of the ſenſe of extenſion by obſerving, that the want of its object is attended with a diſagreeable ſenſation, as well as the exceſs of it. In thoſe hollow muſcles, which have been accuſtomed to it, this diſagreeable ſenſation is called faintneſs, emptineſs, and ſinking; and, when it ariſes to a certain degree, is attended with ſyncope, or a total quieſcence of all motions, but the internal irritative ones, as happens from ſudden loſs of blood, or in the operation of tapping in the dropſy.

VIII.

VIII. *Of the Appetites of Hunger, Thirſt, Heat, Extenſion, the want of freſh Air, animal Love, and the Suckling of Children.*

Hunger is moſt probably perceived by thoſe numerous ramifications of nerves that are ſeen about the upper opening of the ſtomach; and thirſt by the nerves about the fauces, and the top of the gula. The ideas of theſe ſenſes are few in the generality of mankind, but are more numerous in thoſe, who by diſeaſe, or indulgence, deſire particular kinds of foods or liquids.

A ſenſe of heat has already been ſpoken of, which may with propriety be called an appetite, as we painfully deſire it, when it is deficient in quantity.

The ſenſe of extenſion may be ranked amongſt theſe appetites, ſince the deficiency of its object gives diſagreeable ſenſation; when this happens in the arterial ſyſtem, it is called faintneſs, and ſeems to bear ſome analogy to hunger and to cold; which like it are attended with emptineſs of a part of the vaſcular ſyſtem.

The ſenſe of want of freſh air has not been attended to, but is as diſtinct as the others, and the firſt perhaps that we experience after our nativity; from the want of the object of this ſenſe many diſeaſes are produced, as the jail-fever, plague, and other epidemic maladies. Animal love is another appetite, which occurs later in life, and the females of lactiferous animals have another natural inlet of pleaſure or pain from the ſuckling their offſpring. The want of which either owing to the death of their progeny, or to the faſhion of their country, has been fatal to many of the ſex. The males have alſo pectoral glands, which are frequently turgid with a thin milk at their nativity, and are furniſhed with nipples, which erect on titillation

tillation like thoſe of the female; but which ſeem now to be of no further uſe, owing perhaps to ſome change which theſe animals have undergone in the gradual progreſſion of the formation of the earth, and of all that it inhabit.

Theſe ſeven laſt mentioned ſenſes may properly be termed appetites, as they differ from thoſe of touch, ſight, hearing, taſte, and ſmell, in this reſpect; that they are affected with pain as well by the defect of their objects as by the exceſs of them, which is not ſo in the latter. Thus cold and hunger give us pain, as well as an exceſs of heat or ſatiety; but it is not ſo with darkneſs and ſilence.

IX. Before we conclude this Section on the organs of ſenſe, we muſt obſerve, that, as far as we know, there are many more ſenſes, than have been here mentioned, as every gland ſeems to be influenced to ſeparate from the blood, or to abſorb from the cavities of the body, or from the atmoſphere, its appropriated fluid, by the ſtimulus of that fluid on the living gland; and not by mechanical capillary abſorption, nor by chemical affinity. Hence it appears, that each of theſe glands muſt have a peculiar organ to perceive theſe irritations, but as theſe irritations are not ſucceeded by ſenſation, they have not acquired the names of ſenſes.

However when theſe glands are excited into motions ſtronger than uſual, either by the acrimony of their fluids, or by their own irritability being much increaſed, then the ſenſation of pain is produced in them as in all the other ſenſes of the body; and theſe pains are all of different kinds, and hence the glands at this time really become each a different organ of ſenſe, though theſe different kinds of pain have acquired no names.

Thus a great exceſs of light does not give the idea of light but of pain; as in forcibly opening the eye when it is much inflamed. The great exceſs of preſſure or diſtention, as when the point of

a pin

a pin is preſſed upon our ſkin, produces pain, (and when this pain of the ſenſe of diſtention is ſlighter, it is termed itching, or tickling), without any idea of ſolidity or of figure; an exceſs of heat produces ſmarting, of cold another kind of pain; it is probable by this ſenſe of heat the pain produced by cauſtic bodies is perceived, and of electricity, as all theſe are fluids, that permeate, diſtend, or decompoſe the parts that feel them.

SECT.

SECT. XV.

OF THE CLASSES OF IDEAS.

I. 1. *Ideas received in tribes.* 2. *We combine them further, or abſtract from theſe tribes.* 3. *Complex ideas.* 4. *Compounded ideas. Simple ideas, modes, ſubſtances, relations, general ideas.* 6. *Ideas of reflexion.* 7. *Memory and imagination imperfectly defined. Ideal preſence. Memorandum-rings.* II. 1. *Irritative ideas. Perception.* 2. *Senſitive ideas, imagination.* 3. *Voluntary ideas, recollection.* 4. *Aſſociated ideas, ſuggeſtion.* III. 1. *Definitions of perception, memory.* 2. *Reaſoning, judgment, doubting, diſtinguiſhing, comparing.* 3. *Invention.* 4. *Conſciouſneſs.* 5. *Identity.* 6. *Lapſe of time.* 7. *Free-will.*

I. AS the conſtituent elements of the material world are only perceptible to our organs of ſenſe in a ſtate of combination; it follows, that the ideas or ſenſual motions excited by them, are never received ſingly, but ever with a greater or leſs degree of combination. So the colours of bodies or their hardneſſes occur with their figures: every ſmell and taſte has its degree of pungency as well as its peculiar flavour: and each note in muſic is combined with the tone of ſome inſtrument. It appears from hence, that we can be ſenſible of a number of ideas at the ſame time, ſuch as the whiteneſs, hardneſs, and coldneſs, of a ſnow-ball, and

and can experience at the ſame time many irritative ideas of ſurrounding bodies, which we do not attend to, as mentioned in Section VII. 3. 2. But thoſe ideas which belong to the ſame ſenſe, ſeem to be more eaſily combined into ſynchronous tribes, than thoſe which were not received by the ſame ſenſe, as we can more eaſily think of the whiteneſs and figure of a lump of ſugar at the ſame time, than the whiteneſs and ſweetneſs of it.

2. As theſe ideas, or ſenſual motions, are thus excited with greater or leſs degrees of combination; ſo we have a power, when we repeat them either by our volition or ſenſation, to increaſe or diminiſh this degree of combination, that is, to form compounded ideas from thoſe, which were more ſimple; and abſtract ones from thoſe, which were more complex, when they were firſt excited; that is, we can repeat a part or the whole of thoſe ſenſual motions, which did conſtitute our ideas of perception; and the repetition of which now conſtitutes our ideas of recollection, or of imagination.

3. Thoſe ideas, which we repeat without change of the quantity of that combination, with which we firſt received them, are called complex ideas, as when you recollect Weſtminſter Abbey, or the planet Saturn: but it muſt be obſerved, that theſe complex ideas, thus re-excited by volition, ſenſation, or aſſociation, are ſeldom perfect copies of their correſpondent perceptions, except in our dreams, where other external objects do not detract our attention.

4. Thoſe ideas, which are more complex than the natural objects that firſt excited them, have been called compounded ideas, as when we think of a ſphinx, or griffin.

5. And

5. And thoſe that are leſs complex than the correſpondent natural objects, have been termed abſtracted ideas; thus ſweetneſs, and whiteneſs, and ſolidity, are received at the ſame time from a lump of ſugar, yet I can recollect any of theſe qualities without thinking of the others, that were excited along with them.

When ideas are ſo far abſtracted as in the above example, they have been termed ſimple by the writers of metaphyſics, and ſeem indeed to be more complete repetitions of the ideas or ſenſual motions, originally excited by external objects.

Other claſſes of theſe ideas, where the abſtraction has not been ſo great, have been termed, by Mr. Locke, modes, ſubſtances, and relations, but they ſeem only to differ in their degree of abſtraction from the complex ideas that were at firſt excited; for as theſe complex or natural ideas are themſelves imperfect copies of their correſpondent perceptions, ſo theſe abſtract or general ideas are only ſtill more imperfect copies of the ſame perceptions. Thus when I have ſeen an object but once, as a rhinoceros, my abſtract idea of this animal is the ſame as my complex one. I may think more or leſs diſtinctly of a rhinoceros, but it is the very rhinoceros that I ſaw, or ſome part or property of him, which recurs to my mind.

But when any claſs of complex objects becomes the ſubject of converſation, of which I have ſeen many individuals, as a caſtle or an army, ſome property or circumſtance belonging to it is peculiarly alluded to; and then I feel in my own mind, that my abſtract idea of this complex object is only an idea of that part, property, or attitude of it, that employs the preſent converſation, and varies with every ſentence that is ſpoken concerning it. So if any one ſhould ſay, "one may ſit upon a horſe

horſe ſafer than on a camel," my abſtract idea of the two animals includes only an outline of the level back of the one, and the gibboſity on the back of the other. What noiſe is that in the ſtreet?—Some horſes trotting over the pavement. Here my idea of the horſes includes principally the ſhape and motion of their legs. So alſo the abſtract ideas of goodneſs and courage are ſtill more imperfect repreſentations of the objects they were received from; for here we abſtract the material parts, and recollect only the qualities.

Thus we abſtract ſo much from ſome of our complex ideas, that at length it becomes difficult to determine of what perception they partake; and in many inſtances our idea ſeems to be no other than of the ſound or letters of the word, that ſtands for the collective tribe, of which we are ſaid to have an abſtracted idea, as noun, verb, chimæra, apparition.

6. Ideas have been divided into thoſe of perception and thoſe of reflection, but as whatever is perceived muſt be external to the organ that perceives it, all our ideas muſt originally be ideas of perception.

7. Others have divided our ideas into thoſe of memory, and thoſe of imagination; they have ſaid that a recollection of ideas in the order they were received conſtitutes memory, and without that order imagination; but all the ideas of imagination, excepting the few that are termed ſimple ideas, are parts of trains or tribes in the order they were received; as if I think of a ſphinx, or a griffin, the fair face, boſom, wings, claws, tail, are all complex ideas in the order they were received: and it behoves the writers, who adhere

here to this definition, to determine, how ſmall the trains muſt be; that ſhall be called imagination; and how great thoſe, that ſhall be called memory,

Others have thought that the ideas of memory have a greater vivacity than thoſe of imagination: but the ideas of a perſon in ſleep, or in a waking reverie, where the trains connected with ſenſation are uninterrupted, are more vivid and diſtinct than thoſe of memory, ſo that they cannot be diſtinguiſhed by this criterion.

The very ingenious author of the Elements of Criticiſm has deſcribed what he conceives to be a ſpecies of memory, and calls it ideal preſence; but the inſtances he produces are the reveries of ſenſation, and are therefore in truth connections of the imagination, though they are recalled in the order they were received.

The ideas connected by aſſociation are in common diſcourſe attributed to memory, as we talk of memorandum-rings, and tie a knot on our handkerchiefs to bring ſomething into our minds at a diſtance of time. And a ſchool-boy, who can repeat a thouſand unmeaning lines in Lilly's Grammar, is ſaid to have a good memory. But theſe have been already ſhewn to belong to the claſs of aſſociation; and are termed ideas of ſuggeſtion.

II. Laſtly, the method already explained of claſſing ideas into thoſe excited by irritation, ſenſation, volition, or aſſociation, we hope will be found more convenient both for explaining the operations of the mind, and for comparing them with thoſe of the body; and for the illuſtration and the cure of the diſeaſes of both, and which we ſhall here recapitulate.

1. Irritative ideas are thoſe, which are preceded by irritation, which is excited by objects external to the organs of ſenſe: as the idea of that tree, which either I attend to, or which I ſhun in walking near it without attention. In the former caſe it is termed perception, in the latter it is termed ſimply an irritative idea.

2. Senſitive ideas are thoſe, which are preceded by the ſenſation of pleaſure or pain; as the ideas, which conſtitute our dreams or reveries, this is called imagination.

3. Voluntary ideas are thoſe, which are preceded by voluntary exertion, as when I repeat the alphabet backwards: this is called recollection.

4. Aſſociate ideas are thoſe, which are preceded by other ideas or muſcular motions, as when we think over or repeat the alphabet by rote in its uſual order; or ſing a tune we are accuſtomed to; this is called ſuggeſtion.

III. 1. Perceptions ſignify thoſe ideas, which are preceded by irritation and ſucceeded by the ſenſation of pleaſure or pain, for whatever excites our attention intereſts us; that is, it is accompanied with pleaſure or pain; however ſlight may be the degree or quantity of either of them.

The word memory includes two claſſes of ideas, either thoſe which are preceded by voluntary exertion, or thoſe which are ſuggeſted by their aſſociations with other ideas.

2. Reaſoning is that operation of the ſenſorium, by which we excite two or many tribes of ideas; and then re-excite the ideas, in which they differ, or correſpond. If we determine this difference, it is called judgment; if we in vain endeavour to determine it, it is called doubting.

If

If we re-excite the ideas, in which they differ, it is called diſtinguiſhing. If we re-excite thoſe in which they correſpond, it is called comparing.

3. Invention is an operation of the ſenſorium, by which we voluntarily continue to excite one train of ideas, ſuppoſe the deſign of raiſing water by a machine; and at the ſame time attend to all other ideas, which are connected with this by every kind of catenation; and combine or ſeparate them voluntarily for the purpoſe of obtaining ſome end.

For we can create nothing new, we can only combine or ſeparate the ideas, which we have already received by our perceptions: thus if I wiſh to repreſent a monſter, I call to my mind the ideas of every thing diſagreeable and horrible, and combine the naſtineſs and gluttony of a hog, the ſtupidity and obſtinacy of an aſs, with the fur and awkwardneſs of a bear, and call the new combination Caliban. Yet ſuch a monſter may exiſt in nature, as all his attributes are parts of nature. So when I wiſh to repreſent every thing, that is excellent, and amiable; when I combine benevolence with cheerfulneſs, wiſdom, knowledge, taſte, wit, beauty of perſon, and elegance of manners, and aſſociate them in one lady as a pattern to the world, it is called invention; yet ſuch a perſon may exiſt,—ſuch a perſon does exiſt!—It is ————————, who is as much a monſter as Caliban.

4. In reſpect to conſciouſneſs, we are only conſcious of our exiſtence, when we think about it; as we only perceive the lapſe of time, when we attend to it; when we are buſied about other objects, neither the lapſe of time nor the conſciouſneſs of our own exiſtence can occupy our attention. Hence, when we think of our own exiſtence, we only ex-

cite abſtracted or reflex ideas (as they are termed), of our principal pleaſures or pains, of our deſires or averſions, or of the figure, ſolidity, colour, or other properties of our bodies, and call that act of the ſenſorium a conſciouſneſs of our exiſtence. Some philoſophers, I believe it is Des Cartes, has ſaid, "I think, therefore I exiſt." But this is not right reaſoning, becauſe thinking is a mode of exiſtence; and it is thence only ſaying, "I exiſt, therefore I exiſt." For there are three modes of exiſtence, or in the language of grammarians, three kinds of verbs. Firſt, ſimply I am, or exiſt. Secondly, I am acting, or exiſt in a ſtate of activity, as I move. Thirdly, I am ſuffering, or exiſt in a ſtate of being acted upon, as I am moved. The when, and the where, as applicable to this exiſtence, depends on the ſucceſſive motions of our own or of other bodies; and on their reſpective ſituations, as ſpoken of Sect. XIV. 2. 5.

5. Our identity is known by our acquired habits or catenated trains of ideas and muſcular motions; and perhaps, when we compare infancy with old age, in thoſe alone can our identity be ſuppoſed to exiſt. For what elſe is there of ſimilitude between the firſt ſpeck of living entity and the mature man?—every deduction of reaſoning, every ſentiment or paſſion, with every fibre of the corporeal part of our ſyſtem, has been ſubject almoſt to annual mutation; while ſome catenations alone of our ideas and muſcular actions have continued in part unchanged.

By the facility, with which we can in our waking hours voluntarily produce certain ſucceſſive trains of ideas, we know by experience, that we have before reproduced them; that is, we are conſcious of

of a time of our exiſtence previous to the preſent time; that is, of our identity now and heretofore. It is theſe habits of action, theſe catenations of ideas and muſcular motions, which begin with life, and only terminate with it; and which we can in ſome meaſure deliver to our poſterity; as explained in Sect. XXXIX.

6. When the progreſſive motions of external bodies make a part of our preſent catenation of ideas, we attend to the lapſe of time; which appears the longer, the more frequently we thus attend to it; as when we expect ſomething at a certain hour, which much intereſts us, whether it be an agreeable or diſagreeable event; or when we count the paſſing ſeconds on a ſtop-watch.

When an idea of our own perſon, or a reflex idea of our pleaſures and pains, deſires and averſions, makes a part of this catenation, it is termed conſciouſneſs; and if this idea of conſciouſneſs makes a part of a catenation, which we excite by recollection, and know by the facility with which we excite it, that we have before experienced it, it is called identity, as explained above.

7. In reſpect to freewill, it is certain, that we cannot will to think of a new train of ideas, without previouſly thinking of the firſt link of it; as I cannot will to think of a black ſwan, without previouſly thinking of a black ſwan. But if I now think of a tail, I can voluntary recollect all animals which have tails; my will is ſo far free, that I can purſue the ideas linked to this idea of tail, as far as my knowledge of the ſubject extends; but to will without motive is to will without deſire or averſion; which is as abſurd as to feel without pleaſure or pain: they are both ſoleciſms in the terms

terms. So far are we governed by the catenations of motions, which affect both the body and the mind of man, and which begin without our irritability, and end with it.

SECT.

SECT. XVI.

OF INSTINCT.

HAUD EQUIDEM CREDO, QUIA SIT DIVINITUS ILLIS INGENIUM, AUT RERUM FATO PRUDENTIA MAJOR.

VIRG. GEORG. L. I. 415.

I. *Inſtinctive actions defined. Of connate paſſions.* II. *Of the ſenſations and motions of the fœtus in the womb.* III. *Some animals are more perfectly formed than others before nativity. Of learning to walk.* IV. *Of the ſwallowing, breathing, ſucking, pecking, and lapping of young animals.* V. *Of the ſenſe of ſmell, and its uſes to animals. Why cats do not eat their kittens.* VI. *Of the accuracy of ſight in mankind, and their ſenſe of beauty. Of the ſenſe of touch in elephants, monkies, beavers, men.* VII. *Of natural language.* VIII. *The origin of natural language; 1. the language of fear; 2. of grief; 3. of tender pleaſure; 4. of ſerene pleaſure; 5. of anger; 6. of attention.* IX. *Artificial language of turkies, hens, ducklings, wagtails, cuckoos, rabbits, dogs, and nightingales.* X. *Of muſic; of tooth-edge; of a good ear; of architecture.* XI. *Of acquired knowledge; of foxes, rooks, fieldfares, lapwings, dogs, cats, horſes, crows, and pelicans.* XII. *Of birds of paſſage, dormice, ſnakes, bats, ſwallows, quails, ringdoves, ſtare, chaffinch, hoopoe, chatterer, hawfinch, croſsbill, rails and*

and cranes. XIII. *Of birds neſts; of the cuckoo; of ſwallows neſts; of the taylor bird.* XIV. *Of the old ſoldier; of haddocks, cods, and dog fiſh; of the remora; of crabs, herrings, and ſalmon.* XV. *Of ſpiders, caterpillars, ants, and the ichneumon.* XVI. 1. *Of locuſts, gnats;* 2. *bees;* 3. *dormice, flies, worms, ants, and waſps.* XVII. *Of the faculty that diſtinguiſhes man from the brutes.*

I. ALL thoſe internal motions of animal bodies, which contribute to digeſt their aliment, produce their ſecretions, repair their injuries, or increaſe their growth, are performed without our attention or conſciouſneſs. They exiſt as well in our ſleep, as in our waking hours, as well in the fœtus during the time of geſtation, as in the infant after nativity, and proceed with equal regularity in the vegetable as in the animal ſyſtem. Theſe motions have been ſhewn in a former part of this work to depend on the irritations of peculiar fluids, and as they have never been claſſed amongſt the inſtinctive actions of animals, are precluded from our preſent diſquiſition.

But all thoſe actions of men or animals, that are attended with conſciouſneſs, and ſeem neither to have been directed by their appetites, taught by their experience, nor deduced from obſervation or tradition, have been referred to the power of inſtinct. And this power has been explained to be a *divine ſomething*, a kind of inſpiration; whilſt the poor animal, that poſſeſſes it, has been thought little better than *a machine!*

The *irkſomeneſs*, that attends a continued attitude of the body, or the *pains*, that we receive from heat, cold, hunger, or other injurious circumſtances,

tances, excite us to *general locomotion:* and our ſenſes are ſo formed and conſtituted by the hand of nature, that certain objects preſent us with pleaſure, others with pain, and we are induced to approach and embrace theſe, to avoid and abhor thoſe, as ſuch ſenſations direct us.

Thus the palates of ſome animals are gratefully affected by the maſtication of fruits, others of grains, and others of fleſh; and they are thence inſtigated to attain, and to conſume thoſe materials; and are furniſhed with powers of muſcular motion, and of digeſtion proper for ſuch purpoſes.

Theſe *ſenſations* and *deſires* conſtitute a part of our ſyſtem, as our *muſcles* and *bones* conſtitute another part: and hence they may alike be termed *natural* or *connate*; but neither of them can properly be termed *inſtinctive:* as the word inſtinct in its uſual acceptation refers only to the *actions* of animals, as above explained; the origin of theſe *actions* is the ſubject of our preſent enquiry.

The reader is intreated carefully to attend to this definition of *inſtinctive actions*, leſt by uſing the word inſtinct without adjoining any accurate idea to it, he may not only include the natural deſires of love and hunger, and the natural ſenſations of pain or pleaſure, but the figure and contexture of the body, and the faculty of reaſon itſelf under this general term.

II. We experience ſome ſenſations, and perform ſome actions before our nativity; the ſenſations of cold and warmth, agitation and reſt, fulneſs and inanition, are inſtances of the former; and the repeated ſtruggles of the limbs of the fœtus, which begin about the middle of geſtation, and thoſe motions

motions by which it frequently wraps the umbilical chord around its neck or body, and even ſometimes ties it on a knot; are inſtances of the latter. Smellie's Midwifery, (Vol. I. p. 182.)

By a due attention to theſe circumſtances many of the actions of young animals, which at firſt ſight ſeemed only referable to an inexplicable inſtinct, will appear to have been acquired like all other animal actions, that are attended with conſciouſneſs, *by the repeated efforts of our muſcles under the conduct of our ſenſations or deſires.*

The chick in the ſhell begins to move its feet and legs on the ſixth day of incubation (Mattrecian, p. 138); or on the ſeventh day, (Langley); afterwards they are ſeen to move themſelves gently in the liquid that ſurrounds them, and to open and ſhut their mouths, (Harvei, de Generat. p. 62, and 197. Form de Poulet. ii. p. 129). Puppies before the membranes are broken, that involve them, are ſeen to move themſelves, to put out their tongues, and to open and ſhut their mouths, (Harvey, Gipſon, Riolan, Haller). And calves lick themſelves and ſwallow many of their hairs before their nativity: which however puppies do not, (Swammerden, p. 319. Flemyng Phil. Tranſ. Ann. 1755. 42.) And towards the end of geſtation, the fœtus of all animals are proved to drink part of the liquid in which they ſwim, (Haller. Phyſiol. T. 8. 204). The white of egg is found in the mouth and gizzard of the chick, and is nearly or quite conſumed before it is hatched, (Harvie de Generat. 58). And the liquor amnii is found in the mouth and ſtomach of the human fœtus, and of calves; and how elſe ſhould that excrement be produced in the inteſtines of all animals, which is voided in great

great quantity ſoon after their birth; (Gipſon, Med. Eſſays, Edinb. V. i. 13. Halleri Phyſiolog. T. 3. p. 318. and T. 8). In the ſtomach of a calf the quantity of this liquid amounted to about three pints, and the hairs amongſt it were of the ſame colour with thoſe on its ſkin, (Blaſii Anat. Animal, p. m. 122). Theſe facts are atteſted by many other writers of credit, beſides thoſe above mentioned.

III. It has been deemed a ſurpriſing inſtance of inſtinct, that calves and chickens ſhould be able to walk by a few efforts almoſt immediately after their nativity: whilſt the human infant in thoſe countries where he is not incumbered with clothes, as in India, is five or ſix months, and in our climate almoſt a twelvemonth, before he can ſafely ſtand upon his feet.

The ſtruggles of all animals in the womb muſt reſemble their mode of ſwimming, as by this kind of motion they can beſt change their attitude in water. But the ſwimming of the calf and chicken reſembles their manner of walking, which they have thus in part acquired before their nativity, and hence accompliſh it afterwards with very few efforts, whilſt the ſwimming of the human creature reſembles that of the frog, and totally differs from his mode of walking.

There is another circumſtance to be attended to in this affair, that not only the growth of thoſe peculiar parts of animals, which are firſt wanted to ſecure their ſubſiſtence, are in general furtheſt advanced before their nativity: but ſome animals come into the world more completely formed throughout their whole ſyſtem than others: and are thence much forwarder in all their habits of motion,

motion. Thus the colt, and the lamb, are much more perfect animals than the blind puppy, and the naked rabbit; and the chick of the pheaſant, and the partridge, has more perfect plumage, and more perfect eyes, as well as greater aptitude to locomotion, than the callow neſtlings of the dove, and of the wren. The parents of the former only find it neceſſary to ſhew them their food, and to teach them to take it up; whilſt thoſe of the latter are obliged for many days to obtrude it into their gaping mouths.

IV. From the facts mentioned in No. 2. of this Section, it is evinced that the fœtus learns to ſwallow before its nativity; for it is ſeen to open its mouth, and its ſtomach is found filled with the liquid that ſurrounds it. It opens its mouth, either inſtigated by hunger, or by the irkſomeneſs of a continued attitude of the muſcles of its face; the liquor amnii, in which it ſwims, is agreeable to its palate, as it conſiſts of a nouriſhing material, (Haller Phyſ. T. 8. p. 204). It is tempted to experience its taſte further in the mouth, and by a few efforts learns to ſwallow, in the ſame manner as we learn all other animal actions, which are attended with conſciouſneſs, *by the repeated efforts of our muſcles under the conduct of our ſenſations or volitions.*

The inſpiration of air into the lungs is ſo totally different from that of ſwallowing a fluid in which we are immerſed, that it cannot be acquired before our nativity. But at this time, when the circulation of the blood is no longer continued through the placenta, that ſuffocating ſenſation, which we feel about the precordia, when we are in want of freſh air, diſagreeably affects the infant:

and

and all the muſcles of the body are excited into action to relieve this oppreſſion; thoſe of the breaſt, ribs, and diaphragm are found to anſwer this purpoſe, and thus reſpiration is diſcovered, and is continued throughout our lives, as often as the oppreſſion begins to recur. Many infants, both of the human creature, and of quadrupeds, ſtruggle for a minute after they are born before they begin to breathe, (Haller Phyſ. T. 8. p. 400. ib. pt. 2. p. 1). Mr. Buffon thinks the action of the dry air upon the nerves of ſmell of new-born animals, by producing an endeavour to ſneeze, may contribute to induce this firſt inſpiration, and that the rarefaction of the air by the warmth of the lungs contributes to induce expiration, (Hiſt. Nat. Tom. 4. p. 174). Which latter it may effect by producing a diſagreeable ſenſation by its delay, and a conſequent effort to relieve it. Many children ſneeze before they reſpire, but not all, as far as I have obſerved, or can learn from others.

At length, by the direction of its ſenſe of ſmell, or by the officious care of its mother, the young animal approaches the odoriferous rill of its future nouriſhment, already experienced to ſwallow. But in the act of ſwallowing, it is neceſſary nearly to cloſe the mouth, whether the creature be immerſed in the fluid it is about to drink, or not: hence, when the child firſt attempts to ſuck, it does not ſlightly compreſs the nipple between its lips, and ſuck as an adult perſon would do, by abſorbing the milk; but it takes the whole nipple into its mouth for this purpoſe, compreſſes it between its gums, and thus repeatedly chewing (as it were) the nipple, preſſes out the milk; exactly in the ſame manner as it is drawn from the teats of cows by the hands of

of the milkmaid. The celebrated Harvey obſerves, that the fœtus in the womb muſt have ſucked in a part of its nouriſhment, becauſe it knows how to ſuck the minute it is born, as any one may experience by putting a finger between its lips, and becauſe in a few days it forgets this art of ſucking, and cannot without ſome difficulty again acquire it, (Exercit. de Gener. Anim. 48). The ſame obſervation is made by Hippocrates.

A little further experience teaches the young animal to ſuck by abſorption, as well as by compreſſion; that is, to open the cheſt as in the beginning of reſpiration, and thus to rarefy the air in the mouth, that the preſſure of the denſer external atmoſphere may contribute to force out the milk.

The chick yet in the ſhell has learnt to drink by ſwallowing a part of the white of the egg for its food; but not having experienced how to take up and ſwallow ſolid ſeeds, or grains, is either taught by the ſolicitous induſtry of its mother; or by many repeated attempts is enabled at length to diſtinguiſh and to ſwallow this kind of nutriment.

And puppies, though they know how to ſuck like other animals from their previous experience in ſwallowing, and in reſpiration; yet are they long in acquiring the art of lapping with their tongues, which from the flaccidity of their cheeks, and length of their mouths, is afterwards a more convenient way for them to take in water.

V. The ſenſes of ſmell and taſte in many other animals greatly exceed thoſe of mankind, for in civilized ſociety, as our victuals are generally prepared by others, and are adulterated with ſalt, ſpice,

ſpice, oil, and empyreuma, we do not heſitate about eating whatever is ſet before us, and neglect to cultivate theſe ſenſes: whereas other animals try every morſel by the ſmell, before they take it into their mouths, and by the taſte before they ſwallow it: and are led not only each to his proper nouriſhment by this organ of ſenſe, but it alſo at a maturer age directs them in the gratification of their appetite of love. Which may be further underſtood by conſidering the ſympathies of theſe parts deſcribed in Claſs IV. 2. 1. 7. While the human animal is directed to the object of his love by his ſenſe of beauty, as mentioned in No. VI. of this Section. Thus Virgil, Georg. III. 250.

Nonne vides, ut tota tremor pertentat equorum
Corpora, ſi tantum notas odor attulit auras?
Nonne canis nidum veneris naſutus odore
Quæriut, et erranti trahitur ſublambere linguâ?
Reſpuit at guſtum cupidus, labüſq retractis
Elevat os, trepidanſque novis impellitur æſtris,
Inſerit et vivum felici vomere ſemen.
Quam tenui filo cæcos adnectit amores
Docta Venus, vitæque monet renovare favillam!

Anon.

The following curious experiment is related by Galen. "On diſſecting a goat great with young I found a briſk embryon, and having detached it from the matrix, and ſnatching it away before it ſaw its dam, I brought it into a certain room, where there were many veſſels, ſome filled with wine, others with oil, ſome with honey, others with milk, or ſome other liquor; and in others were grains and fruits; we firſt obſerved the young animal

animal get upon its feet, and walk; then it ſhook itſelf, and afterwards ſcratched its ſide with one of its feet: then we ſaw it ſmelling to every one of theſe things, that were ſet in the room; and when it had ſmelt to them all, it drank up the milk." L. 6. de locis. cap. 6.

Parturient quadrupeds, as cats, and bitches, and ſows, are led by their ſenſe of ſmell to eat the placenta as other common food; why then do they not devour their whole progeny, as is repreſented in an antient emblem of Time? This is ſaid ſometimes to happen in the unnatural ſtate in which we confine ſows; and indeed nature would ſeem to have endangered her offſpring in this nice circumſtance! But at this time the ſtimulus of the milk in the tumid teats of the mother excites her to look out for, and to deſire ſome unknown circumſtance to relieve her. At the ſame time the ſmell of the milk attracts the exertions of the young animals towards its ſource, and thus the delighted mother diſcovers a new appetite, as mentioned in Sect. XIV. 3. and her little progeny are led to receive and to communicate pleaſure by this moſt beautiful contrivance.

VI. But though the human ſpecies in ſome of their ſenſations are much inferior to other animals, yet the accuracy of the ſenſe of touch, which they poſſeſs in ſo eminent a degree, gives them a great ſuperiority of underſtanding; as is well obſerved by the ingenious Mr. Buffon. The extremities of other animals terminate in horns, and hoofs, and claws, very unfit for the ſenſation of touch; whilſt the human hand is finely adapted to encompaſs its object with this organ of ſenſe.

The

The elephant is indeed endued with a fine ſenſe of feeling at the extremity of his proboſcis, and hence has acquired much more accurate ideas of touch and of ſight than moſt other creatures. The two following inſtances of the ſagacity of theſe animals may entertain the reader, as they were told me by ſome gentlemen of diſtinct obſervation, and undoubted veracity, who had been much converſant with our eaſtern ſettlements. Firſt, the elephants that are uſed to carry the baggage of our armies, are put each under the care of one of the natives of Indoſtan, and whilſt himſelf and his wife go into the woods to collect leaves and branches of trees for his food, they fix him to the ground by a length of chain, and frequently leave a child yet unable to walk, under his protection: and the intelligent animal not only defends it, but as it creeps about, when it arrives near the extremity of his chain, he wraps his trunk gently round its body, and brings it again into the centre of his circle. Secondly, the traitor elephants are taught to walk on a narrow path between two pit-falls, which are covered with turf, and then to go into the woods, and to ſeduce the wild elephants to come that way, who fall into theſe wells, whilſt he paſſes ſafe between them: and it is univerſally obſerved, that thoſe wild elephants that eſcape the ſnare, purſue the traitor with the utmoſt vehemence, and if they can overtake him, which ſometimes happens, they always beat him to death.

The monkey has a hand well enough adapted for the ſenſe of touch, which contributes to his great facility of imitation; but in taking objects with his hands, as a ſtick or an apple, he puts his thumb on the ſame ſide of them with his fingers, inſtead of counteracting the preſſure of his fingers with it: from this neglect he is much ſlower in acquiring the figures of objects, as he is leſs able to determine

the diſtances or diameters of their parts, or to diſtinguiſh their vis inertiæ from their hardneſs. Helvetius adds, that the ſhortneſs of his life, his being fugitive before mankind, and his not inhabiting all climates, combine to prevent his improvement. (De l'Eſprit. T. 1. p.) There is however at this time an old monkey ſhewn in Exeter Change, London, who having loſt his teeth, when nuts are given to him, takes a ſtone into his hand, and cracks them with it one by one; thus uſing tools to effect his purpoſe like mankind.

The beaver is another animal that makes uſe of his hands, and if we may credit the reports of travellers, is poſſeſſed of amazing ingenuity. This however, Mr. Buffon affirms, is only where they exiſt in large numbers, and in countries thinly peopled with men; while in France in their ſolitary ſtate they ſhew no uncommon ingenuity.

Indeed all the quadrupeds, that have collar-bones, (claviculæ) uſe their fore-limbs in ſome meaſure as we uſe our hands, as the cat, ſquirrel, tiger, bear and lion; and as they exerciſe the ſenſe of touch more univerſally than other animals, ſo are they more ſagacious in watching and ſurpriſing their prey. All thoſe birds, that uſe their claws for hands, as the hawk, parrot, and cuckoo, appear to be more docile and intelligent; though the gregarious tribes of birds have more acquired knowledge.

Now as the images, that are painted on the retina of the eye, are no other than ſigns, which recall to our imaginations the objects we had before examined by the organ of touch, as is fully demonſtrated by Dr. Berkley, in his treatiſe on viſion; it follows that the human creature has greatly more accurate and diſtinct ſenſe of viſion than that of any other animal. Whence as he advances to maturity he gradually acquires a ſenſe of female beauty, which

which at this time directs him to the object of his new paſſion.

Sentimental love, as diſtinguiſhed from the animal paſſion of that name, with which it is frequently accompanied, conſiſts in the deſire or ſenſation of beholding, embracing, and ſaluting a beautiful object.

The characteriſtic of beauty therefore is that it is the object of love; and though many other objects are in common language called beautiful, yet they are only called ſo metaphorically, and ought to be termed agreeable. A Grecian temple may give us the pleaſurable idea of ſublimity, a Gothic temple may give us the pleaſurable idea of variety, and a modern houſe the pleaſurable idea of utility; muſic and poetry may inſpire our love by aſſociation of ideas; but none of theſe, except metaphorically, can be termed beautiful; as we have no wiſh to embrace or ſalute them.

Our perception of beauty conſiſts in our recognition by the ſenſe of viſion of thoſe objects, firſt, which have before inſpired our love by the pleaſure, which they have afforded to many of our ſenſes: as to our ſenſe of warmth, of touch, of ſmell, of taſte, hunger and thirſt; and, ſecondly, which bear any analogy of form to ſuch objects.

When the babe, ſoon after it is born into this cold world, is applied to its mother's boſom; its ſenſe of perceiving warmth is firſt agreeably affected; next its ſenſe of ſmell is delighted with the odour of her milk; then its taſte is gratified by the flavour of it: afterwards the appetites of hunger and of thirſt afford pleaſure by the poſſeſſion of their objects, and by the ſubſequent digeſtion of the aliment; and, laſtly, the ſenſe of touch is delighted by the ſoftneſs and ſmoothneſs of the milky fountain, the ſource of ſuch variety of happineſs.

All theſe various kinds of pleaſure at length become aſſociated with the form of the mother's breaſt; which the infant embraces with its hands, preſſes with its lips, and watches with its eyes; and thus acquires more accurate ideas of the form of its mother's boſom, than of the odour and flavour or warmth, which it perceives by its other ſenſes. And hence at our maturer years, when any object of viſion is preſented to us, which by its waving or ſpiral lines bears any ſimilitude to the form of the female boſom, whether it be found in a landſcape with ſoft gradations of riſing and deſcending ſurface, or in the forms of ſome antique vaſes, or in other works of the pencil or the chiſſel, we feel a general glow of delight, which ſeems to influence all our ſenſes; and, if the object be not too large, we experience an attraction to embrace it with our arms, and to ſalute it with our lips, as we did in our early infancy the boſom of our mother. And thus we find, according to the ingenious idea of Hogarth, that the waving lines of beauty were originally taken from the temple of Venus.

This animal attraction is love; which is a ſenſation, when the object is preſent; and a deſire, when it is abſent. Which conſtitutes the pureſt ſource of human felicity, the cordial drop in the otherwiſe vapid cup of life, and which overpays mankind for the care and labour, which are attached to the pre-eminence of his ſituation above other animals.

It ſhould have been obſerved, that colour as well as form ſometimes enters into our idea of a beautiful object, as a good complexion for inſtance, becauſe a fine or fair colour is in general a ſign of health, and conveys to us an idea of the warmth of the object; and a pale countenance on the contrary gives an idea of its being cold to the touch.

It was before remarked, that young animals uſe their lips to diſtinguiſh the forms of things, as well as

as their fingers, and hence we learn the origin of our inclination to ſalute beautiful objects with our lips. For a definition of Grace, ſee Claſs III. 1. 2. 4.

VII. There are two ways by which we become acquainted with the paſſions of others: firſt, by having obſerved the effects of them, as of fear or anger, on our own bodies, we know at ſight when others are under the influence of theſe affections. So when two cocks are preparing to fight, each feels the feathers riſe round his own neck, and knows from the ſame ſign the diſpoſition of his adverſary; and children long before they can ſpeak, or underſtand the language of their parents, may be frightened by an angry countenance, or ſoothed by ſmiles and blandiſhments.

Secondly, when we put ourſelves into the attitude that any paſſion naturally occaſions, we ſoon in ſome degree acquire that paſſion; hence when thoſe that ſcold indulge themſelves in loud oaths, and violent actions of the arms, they increaſe their anger by the mode of expreſſing themſelves: and on the contrary the counterfeited ſmile of pleaſure in diſagreeable company ſoon brings along with it a portion of the reality, as is well illuſtrated by Mr. Burke. (Eſſay on the Sublime and Beautiful.)

This latter method of entering into the paſſions of others is rendered of very extenſive uſe by the pleaſure we take in imitation, which is every day preſented before our eyes, in the actions of children, and indeed in all the cuſtoms and faſhions of the world. From this our aptitude to imitation, ariſes what is generally underſtood by the word ſympathy ſo well explained by Dr. Smith of Glaſgow. Thus the appearance of a cheerful countenance gives us pleaſure, and of a melancholy one makes us ſorrowful. Yawning and ſometimes vomiting are thus propagated by ſympathy, and

ſome

ſome people of delicate fibres, at the preſence of a ſpectacle of miſery, have felt pain in the ſame parts of their own bodies, that were diſeaſed or mangled in the other. Amongſt the writers of antiquity Ariſtotle thought this aptitude to imitation an eſſential property of the human ſpecies, and calls man an imitative animal. Το ζωον μιμητικον.

Theſe then are the natural ſigns by which we underſtand each other, and on this ſlender baſis is built all human language. For without ſome natural ſigns, no artificial ones could have been invented or underſtood, as is very ingeniouſly obſerved by Dr. Reid. (Inquiry into the Human Mind.)

VIII. The origin of this univerſal language is a ſubject of the higheſt curioſity, the knowledge of which has always been thought utterly inacceſſible. A part of which we ſhall however here attempt.

Light, ſound, and odours, are unknown to the fœtus in the womb, which, except the few ſenſations and motions already mentioned, ſleeps away its time inſenſible of the buſy world. But the moment he arrives into day, he begins to experience many vivid pains and pleaſures; theſe are at the ſame time attended with certain muſcular motions, and from this their early, and individual aſſociation, they acquire habits of occurring together, that are afterwards indiſſoluble.

1. *Of Fear.*

As ſoon as the young animal is born, the firſt important ſenſations, that occur to him, are occaſioned by the oppreſſion about his precordia for want of reſpiration, and by his ſudden tranſition from ninety-eight degrees of heat into ſo cold a climate. —He trembles, that is, he exerts alternately all the muſcles of his body, to enfranchiſe himſelf from the

the oppreſſion about his boſom, and begins to breathe with frequent and ſhort reſpirations; at the ſame time the cold contracts his red ſkin, gradually turning it pale; the contents of the bladder and of the bowels are evacuated: and from the experience of theſe firſt diſagreeable ſenſations the paſſion of fear is excited, which is no other than the expectation of diſagreeable ſenſations. This early aſſociation of motions and ſenſations perſiſts throughout life; the paſſion of fear produces a cold and pale ſkin, with tremblings, quick reſpiration, and an evacuation of the bladder and bowels, and thus conſtitutes the natural or univerſal language of this paſſion.

On obſerving a Canary bird this morning, January 28, 1772, at the houſe of Mr. Harvey, near Tutbury, in Derbyſhire, I was told it always fainted away, when its cage was cleaned, and deſired to ſee the experiment. The cage being taken from the ceiling, and its bottom drawn out, the bird began to tremble, and turned quite white about the root of his bill: he then opened his mouth as if for breath, and reſpired quick, ſtood ſtraighter upon his perch, hung his wings, ſpread his tail, cloſed his eyes, and appeared quite ſtiff and cataleptic for near half an hour, and at length with much trembling and deep reſpirations came gradually to himſelf.

2. *Of Grief.*

That the internal membrane of the noſtrils may be kept always moiſt, for the better perception of odours, there are two canals, that conduct the tears after they have done their office in moiſtening and cleaning the ball of the eye into a ſack, which is called the lacrymal ſack; and from which there is a duct,

ſome people of delicate fibres, at the preſence of a ſpectacle of miſery, have felt pain in the ſame parts of their own bodies, that were diſeaſed or mangled in the other. Amongſt the writers of antiquity Ariſtotle thought this aptitude to imitation an eſſential property of the human ſpecies, and calls man an imitative animal. Το ζωον μιμητικον.

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As ſoon as the young animal is born, the firſt important ſenſations, that occur to him, are occaſioned by the oppreſſion about his precordia for want of reſpiration, and by his ſudden tranſition from ninety-eight degrees of heat into ſo cold a climate. —He trembles, that is, he exerts alternately all the muſcles of his body, to enfranchiſe himſelf from the

the oppreſſion about his boſom, and begins to breathe with frequent and ſhort reſpirations; at the ſame time the cold contracts his red ſkin, gradually turning it pale; the contents of the bladder and of the bowels are evacuated: and from the experience of theſe firſt diſagreeable ſenſations the paſſion of fear is excited, which is no other than the expectation of diſagreeable ſenſations. This early aſſociation of motions and ſenſations perſiſts throughout life; the paſſion of fear produces a cold and pale ſkin, with tremblings, quick reſpiration, and an evacuation of the bladder and bowels, and thus conſtitutes the natural or univerſal language of this paſſion.

On obſerving a Canary bird this morning, January 28, 1772, at the houſe of Mr. Harvey, near Tutbury, in Derbyſhire, I was told it always fainted away, when its cage was cleaned, and deſired to ſee the experiment. The cage being taken from the ceiling, and its bottom drawn out, the bird began to tremble, and turned quite white about the root of his bill: he then opened his mouth as if for breath, and reſpired quick, ſtood ſtraighter upon his perch, hung his wings, ſpread his tail, cloſed his eyes, and appeared quite ſtiff and cataleptic for near half an hour, and at length with much trembling and deep reſpirations came gradually to himſelf.

2. *Of Grief.*

That the internal membrane of the noſtrils may be kept always moiſt, for the better perception of odours, there are two canals, that conduct the tears after they have done their office in moiſtening and cleaning the ball of the eye into a ſack, which is called the lacrymal ſack; and from which there is a duct,

duct, that opens into the noſtrils: the aperture of this duct is formed of exquiſite ſenſibility, and when it is ſtimulated by odorous particles, or by the dryneſs or coldneſs of the air, the ſack contracts itſelf, and pours more of its contained moiſture on the organ of ſmell. By this contrivance the organ is rendered more fit for perceiving ſuch odours, and is preſerved from being injured by thoſe that are more ſtrong or corroſive. Many other receptacles of peculiar fluids diſgorge their contents, when the ends of their ducts are ſtimulated; as the gall bladder, when the contents of the duodenum ſtimulate the extremity of the common bile duct: and the ſalivary glands, when the termination of their ducts in the mouth are excited by the ſtimulus of the food we maſticate. Atque veſiculæ ſeminales ſuum exprimunt fluidum glande penis fricatâ.

The coldneſs and dryneſs of the atmoſphere, compared with the warmth and moiſture, which the newborn infant had juſt before experienced, diſagreeably affects the aperture of this lacrymal ſack: the tears, that are contained in this ſack, are poured into the noſtrils, and a further ſupply is ſecreted by the lacrymal glands, and diffuſed upon the eye-balls; as is very viſible in the eyes and noſtrils of children ſoon after their nativity. The ſame happens to us at our maturer age, for in ſevere froſty weather, ſnivelling and tears are produced by the coldneſs and dryneſs of the air.

But the lacrymal glands, which ſeparate the tears from the blood, are ſituated on the upper external part of the globes of each eye; and, when a greater quantity of tears are wanted, we contract the forehead, and bring down the eye-brows, and uſe many other diſtortions of the face, to compreſs theſe glands.

Now as the ſuffocating ſenſation, that produces reſpiration, is removed almoſt as ſoon as perceived, and does not recur again: this diſagreeable irrita-

tion

tion of the lacrymal ducts, as it muſt frequently recur, till the tender organ becomes uſed to variety of odours, is one of the firſt pains that is repeatedly attended to: and hence throughout our infancy, and in many people throughout their lives, all diſagreeable ſenſations are attended with ſnivelling at the noſe, a profuſion of tears, and ſome peculiar diſtortions of countenance: according to the laws of early aſſociation before mentioned, which conſtitutes the natural or univerſal language of grief.

You may aſſure yourſelf of the truth of this obſervation, if you will attend to what paſſes, when you read a diſtreſsful tale alone; before the tears overflow your eyes, you will invariably feel a titillation at that extremity of the lacrymal duct, which terminates in the noſtril, then the compreſſion of the eyes ſucceeds, and the profuſion of tears.

Linnæus aſſerts, that the female bear ſheds tears in grief; the ſame has been ſaid of the hind, and ſome other animals.

3. *Of Tender Pleaſure.*

The firſt moſt lively impreſſion of pleaſure, that the infant enjoys after its nativity, is excited by the odour of its mother's milk. The organ of ſmell is irritated by this perfume, and the lacrymal ſack empties itſelf into the noſtrils, as before explained, and an increaſe of tears is poured into the eyes. Any one may obſerve this, when very young infants are about to ſuck; for at thoſe early periods of life, the ſenſation affects the organ of ſmell, much more powerfully, than after the repeated habits of ſmelling has inured it to odours of common ſtrength: and in our adult years, the ſtronger ſmells, though they are at the ſame time agreeable to us, as of volatile ſpirits, continue to produce an increaſed ſecretion of tears.

This pleaſing ſenſation of ſmell is followed by the early affection of the infant to the mother that ſuc-

kles

kles it, and hence the tender feelings of gratitude and love, as well as of hopeleſs grief, are ever after joined with the titillation of the extremity of the lacrymal ducts, and a profuſion of tears.

Nor is it ſingular, that the lacrymal ſack ſhould be influenced by pleaſing ideas, as the ſight of agreeable food produces the ſame effect on the ſalivary glands. Ac dum vidimus inſomniis laſcivæ puellæ ſimulacrum, tenditur penis.

Lambs ſhake or wriggle their tails, at the time when they firſt ſuck, to get free of the hard excrement, which had been long lodged in their bowels. Hence this becomes afterwards a mark of pleaſure in them, and in dogs, and other tailed animals. But cats gently extend and contract their paws when they are pleaſed, and purr by drawing in their breath, both which reſemble their manner of ſucking, and thus become their language of pleaſure, for theſe animals having collar-bones uſe their paws like hands when they ſuck, which dogs and ſheep do not.

4. *Of Serene Pleaſure.*

In the action of ſucking, the lips of the infant are cloſed around the nipple of its mother, till he has filled his ſtomach, and the pleaſure occaſioned by the ſtimulus of this grateful food ſucceeds. Then the ſphincter of the mouth, fatigued by the continued action of ſucking, is relaxed; and the antagoniſt muſcles of the face gently acting, produce the ſmile of pleaſure: as cannot but be ſeen by all who are converſant with children.

Hence this ſmile during our lives is aſſociated with gentle pleaſure; it is viſible in kittens, and puppies, when they are played with, and tickled; but more particularly marks the human features. For in children this expreſſion of pleaſure is much encouraged, by their imitation of their parents, or friends; who

who generally addreſs them with a ſmiling countenance: and hence ſome nations are more remarkable for the gaiety, and others for the gravity of their looks.

5. *Of Anger.*

The actions that conſtitute the mode of fighting, are the immediate language of anger in all animals; and a preparation for theſe actions is the natural language of threatening. Hence the human creature clenches his fiſt, and ſternly ſurveys his adverſary, as if meditating where to make the attack; the ram, and the bull, draws himſelf ſome ſteps backwards, and levels his horns; and the horſe, as he moſt frequently fights by ſtriking with his hinder feet, turns his heels to his foe, and bends back his ears, to liſten out the place of his adverſary, that the threatened blow may not be ineffectual.

6. *Of Attention.*

The eye takes in at once but half our horizon, and that only in the day, and our ſmell informs us of no very diſtant objects, hence we confide principally in the organ of hearing to apprize us of danger: when we hear any the ſmalleſt ſound, that we cannot immediately account for, our fears are alarmed, we ſuſpend our ſteps, hold every muſcle ſtill, open our mouths a little, erect our ears, and liſten to gain further information: and this by habit becomes the general language of attention to objects of ſight, as well as of hearing; and even to the ſucceſſive trains of our ideas.

The natural language of violent pain, which is expreſſed by writhing the body, grinning, and ſcreaming; and that of tumultuous pleaſure, expreſſed in loud laughter; belong to Section XXXIV. on Diſeaſes from Volition.

IX. It

IX. It muſt have already appeared to the reader, that all other animals, as well as man, are poſſeſſed of this natural language of the paſſions, expreſſed in ſigns or tones; and we ſhall endeavour to evince, that thoſe animals, which have preſerved themſelves from being enſlaved by mankind, and are aſſociated in flocks, are alſo poſſeſſed of ſome artificial language, and of ſome traditional knowledge.

The mother-turkey, when ſhe eyes a kite hovering high in air, has either ſeen her own parents thrown into fear at his preſence, or has by obſervation been acquainted with his dangerous deſigns upon her young. She becomes agitated with fear, and uſes the natural language of that paſſion, her young ones catch the fear by imitation, and in an inſtant conceal themſelves in the graſs.

At the ſame time that ſhe ſhews her fears by her geſture and deportment, ſhe uſes a certain exclamation, Koe-ut, Koe-ut, and the young ones afterwards know, when they hear this note, though they do not ſee their dam, that the preſence of their adverſary is denounced, and hide themſelves as before.

The wild tribes of birds have very frequent opportunities of knowing their enemies, by obſerving the deſtruction they make among their progeny, of which every year but a ſmall part eſcapes to maturity: but to our domeſtic birds theſe opportunities ſo rarely occur, that their knowledge of their diſtant enemies muſt frequently be delivered by tradition in the manner above explained, through many generations.

This note of danger, as well as the other notes of the mother turkey, when ſhe calls her flock to their food, or to ſleep under her wings, appears to be an artificial language, both as expreſſed by the mother, and as underſtood by the progeny. For a hen teaches this language with equal eaſe to the ducklings ſhe has hatched from ſuppoſititious eggs, and

educates

educates as her own offspring: and the wagtails, or hedge-ſparrows, learn it from the young cuckoo their foſter nurſling, and ſupply him with food long after he can fly about, whenever they hear his cuckooing, which Linneus tells us, is his call of hunger, (Syſt. Nat.) And all our domeſtic animals are readily taught to come to us for food, when we uſe one tone of voice, and to fly from our anger, when we uſe another.

Rabbits, as they cannot eaſily articulate ſounds, and are formed into ſocieties, that live under ground, have a very different method of giving alarm. When danger is threatened, they thump on the ground with one of their hinder feet, and produce a ſound, that can be heard a great way by animals near the ſurface of the earth, which would ſeem to be an artificial ſign both from its ſingularity and its aptneſs to the ſituation of the animal.

The rabbits on the iſland of Sor, near Senegal, have white fleſh, and are well taſted, but do not burrow in the earth, ſo that we may ſuſpect their digging themſelves houſes in this cold climate is an acquired art, as well as their note of alarm, (Adanſon's Voyage to Senegal).

The barking of dogs is another curious note of alarm, and would ſeem to be an acquired language, rather than a natural ſign: for "in the iſland of Juan Fernandes, the dogs did not attempt to bark, till ſome European dogs were put among them, and then they gradually begun to imitate them, but in a ſtrange manner at firſt, as if they were learning a thing that was not natural to them," (Voyage to South America by Don G. Juan, and Don Ant. de Ulloa. B. 2. c. 4.)

Linnæus alſo obſerves, that the dogs of South America do not bark at ſtrangers, (Syſt. Nat.) And the European dogs, that have been carried to Guinea, are ſaid in three or four generations to ceaſe to bark, and

and only howl, like the dogs that are natives of that coaſt, (World Diſplayed, Vol. XVII. p. 26.)

A circumſtance not diſſimilar to this, and equally curious, is mentioned by Kircherus, de Muſurgia, in his Chapter de Luſciniis, "That the young nightingales that are hatched under other birds, never ſing till they are inſtructed by the company of other nightingales." And Johnſton affirms, that the nightingales that viſit Scotland, have not the ſame harmony as thoſe of Italy, (Pennant's Zoology, octavo, p. 255); which would lead us to ſuſpect that the ſinging of birds, like human muſic, is an artificial language, rather than a natural expreſſion of paſſion.

X. Our muſic like our language, is perhaps entirely conſtituted of artificial tones, which by habit ſuggeſt certain agreeable paſſions. For the ſame combination of notes and tones do not excite devotion, love, or poetic melancholy in a native of Indoſtan and of Europe. And "the Highlander has the ſame warlike ideas annexed to the ſound of a bagpipe (an inſtrument which an Engliſhman derides), as the Engliſhman has to that of a trumpet or fife," (Dr. Brown's Union of Poetry and Muſic, p. 58.) So "the muſic of the Turks is very different from the Italian, and the people of Fez and Morocco have again a different kind, which to us appears very rough and horrid, but is highly pleaſing to them," (L' Arte Armoniaca a Giorgio Antoniotto). Hence we ſee why the Italian opera does not delight an untutored Engliſhman; and why thoſe, who are unaccuſtomed to muſic, are more pleaſed with a tune, the ſecond or third time they hear it, than the firſt. For then the ſame melodious train of ſounds excites the melancholy, they had learned from the ſong; or the ſame vivid combination of them recalls all the mirthful ideas of the dance and company.

Even the ſounds, that were once diſagreeable to us, may by habit be aſſociated with other ideas, ſo as to become

become agreeable. Father Lafitau, in his account of the Iroquois, ſays "the muſic and dance of thoſe Americans, have ſomething in them extremely barbarous, which at firſt diſguſts. We grow reconciled to them by degrees, and in the end partake of them with pleaſure, the ſavages themſelves are fond of them to diſtraction," (Mœurs des Savages, Tom. ii.)

There are indeed a few ſounds, that we very generally aſſociate with agreeable ideas, as the whiſtling of birds, or purring of animals, that are delighted; and ſome others, that we as generally aſſociate with diſagreeable ideas, as the cries of animals in pain, the hiſs of ſome of them in anger, and the midnight howl of beaſts of prey. Yet we receive no terrible or ſublime ideas from the lowing of a cow, or the braying of an aſs. Which evinces, that theſe emotions are owing to previous aſſociations. So if the rumbling of a carriage in the ſtreet be for a moment miſtaken for thunder, we receive a ſublime ſenſation, which ceaſes as ſoon as ſoon as we know it is the noiſe of a coach and ſix.

There are other diſagreeable ſounds, that are ſaid to ſet the teeth on edge; which, as they have always been thought a neceſſary effect of certain diſcordant notes, become a proper ſubject of our inquiry. Every one in his childhood has repeatedly bit a part of the glaſs or earthen veſſel, in which his food has been given him, and has thence had a very diſagreeable ſenſation in the teeth, which ſenſation was deſigned by nature to prevent us from exerting them on objects harder than themſelves. The jarring ſound produced between the cup and the teeth is always attendant on this diſagreeable ſenſation: and ever after when ſuch a ſound is accidentally produced by the conflict of two hard bodies, we feel by aſſociation of ideas the concomitant diſagreeable ſenſation in our teeth.

Others

Others have in their infancy frequently held the corner of a ſilk handkerchief in their mouth, or the end of the velvet cape of their coat, whilſt their companions in play have plucked it from them, and have given another diſagreeable ſenſation to their teeth, which has afterwards recurred on touching thoſe materials. And the ſight of a knife drawn along a china plate, though no ſound is excited by it, and even the imagination of ſuch a knife and plate ſo ſcraped together, I know by repeated experience will produce the ſame diſagreeable ſenſation of the teeth.

Theſe circumſtances indiſputably prove, that this ſenſation of the tooth-edge is owing to aſſociated ideas; as it is equally excitable by ſight, touch, hearing, or imagination.

In reſpect to the artificial proportions of ſound excited by muſical inſtruments, thoſe, who have early in life aſſociated them with agreeable ideas, and have nicely attended to diſtinguiſh them from each other, are ſaid to have a good ear, in that country where ſuch proportions are in faſhion: and not from any ſuperior perfection in the organ of hearing, or any inſtinctive ſympathy between certain ſounds and paſſions.

I have obſerved a child to be exquiſitely delighted with muſic, and who could with great facility learn to ſing any tune that he heard diſtinctly, and yet whoſe organ of hearing was ſo imperfect, that it was neceſſary to ſpeak louder to him in common converſation than to others.

Our muſic, like our architecture, ſeems to have no foundation in nature, they are both arts purely of human creation, as they imitate nothing. And the profeſſors of them have only claſſed thoſe circumſtances, that are moſt agreeable to the accidental taſte of their age, or country; and have called it Proportion. But this proportion muſt always fluctuate,

tuate, as it reſts on the caprices, that are introduced into our minds by our various modes of education. And theſe fluctuations of taſte muſt become more frequent in the preſent age, where mankind have enfranchiſed themſelves from the blind obedience to the rules of antiquity in perhaps every ſcience, but that of architecture. See Sect. XII. 7. 3.

XI. There are many articles of knowledge, which the animals in cultivated countries ſeem to learn very early in their lives, either from each other, or from experience, or obſervation: one of the moſt general of theſe is to avoid mankind. There is ſo great a reſemblance in the natural language of the paſſions of all animals, that we generally know, when they are in a pacific, or in a malevolent humour, they have the ſame knowledge of us; and hence we can ſcold them from us by ſome tones and geſtures, and could poſſibly attract them to us by others, if they were not already apprized of our general malevolence towards them. Mr. Gmelin, Profeſſor at Peterſburg, aſſures us, that in his journey into Siberia, undertaken by order of the Empreſs of Ruſſia, he ſaw foxes, that expreſſed no fear of himſelf or companions, but permitted him to come quite near them, having never ſeen the human creature before. And Mr. Bougainville relates, that at his arrival at the Malouine, or Falkland's Iſlands, which were not inhabited by men, all the animals came about himſelf and his people; the fowls ſettling upon their heads and ſhoulders, and the quadrupeds running about their feet. From the difficulty of acquiring the confidence of old animals, and the eaſe of taming young ones, it appears that the fear, they all conceive at the ſight of mankind, is an acquired article of knowledge.

This knowledge is more nicely underſtood by rooks, who are formed into ſocieties, and build, as

it were, cities over our heads; they evidently diſtinguiſh, that the danger is greater when a man is armed with a gun. Every one has ſeen this, who in the ſpring of the year has walked under a rookery with a gun in his hand: the inhabitants of the trees riſe on their wings, and ſcream to the unfledged young to ſhrink into their neſts from the ſight of the enemy. The vulgar obſerving this circumſtance ſo uniformly to occur, aſſert that rooks can ſmell gun-powder.

The fieldfairs, (turdus pilarus) which breed in Norway, and come hither in the cold ſeaſon for our winter berries; as they are aſſociated in flocks, and are in a foreign country, have evident marks of keeping a kind of watch, to remark and announce the appearance of danger. On approaching a tree, that is covered with them, they continue fearleſs till one at the extremity of the buſh riſing on his wings gives a loud and peculiar note of alarm, when they all immediately fly, except one other, who continues till you approach ſtill nearer, to certify as it were the reality of the danger, and then he alſo flies off repeating the note of alarm.

And in the woods about Senegal there is a bird called uett-uett by the negroes, and ſquallers by the French, which, as ſoon as they ſee a man, ſet up a loud ſcream, and keep flying round him, asif their intent was to warn other birds, which uponhearing the cry immediately take wing. Theſe birds are the bane of ſportſmen, and frequently put me into a paſſion, and obliged me to ſhoot them (Adanſon's Voyage to Senegal, 78). For the ſame intent the leſſer birds of our climate ſeem to fly after a hawk, cuckoo, or owl, and ſcream to prevent their companions from being ſurpriſed by the general enemies of themſelves, or of their eggs and progeny.

But the lapwing, (charadrius pluvialis Lin.) when her unfledged offspring run about the marſhes, where

where they were hatched, not only gives the note of alarm at the approach of men or dogs, that her young may conceal themſelves; but flying and ſcreaming near the adverſary, ſhe appears more ſolicitous and impatient, as he recedes from her family, and thus endeavours to miſlead him, and frequently ſucceeds in her deſign. Theſe laſt inſtances are ſo appoſite to the ſituation, rather than to the natures of the creatures, that uſe them; and are ſo ſimilar to the actions of men in the ſame circumſtances, that we cannot but believe, that they proceed from a ſimilar principle.

Miſs M. E. Jacſon acquainted me, that ſhe witneſſed this autumn an agreeable inſtance of ſagacity in a little bird, which ſeemed to uſe the means to obtain an end; the bird repeatedly hopped upon a poppy-ſtem, and ſhook the head with its bill, till many ſeeds were ſcattered, then it ſettled on the ground, and eat the ſeeds, and again repeated the ſame management. Sept. 1, 1794.

On the northern coaſt of Ireland a friend of mine ſaw above a hundred crows at once preying upon muſcles; each crow took a muſcle up into the air twenty or forty yards high, and let it fall on the ſtones, and thus by breaking the ſhell, got poſſeſſion of the animal.—A certain philoſopher (I think it was Anaxagoras) walking along the ſea-ſhore to gather ſhells, one of theſe unlucky birds miſtaking his bald head for a ſtone, dropped a ſhell-fiſh upon it, and killed at once a philoſopher and an oyſter.

Our domeſtic animals, that have ſome liberty, are alſo poſſeſſed of ſome peculiar traditional knowledge; dogs and cats have been forced into each other's ſociety, though naturally animals of a very different kind, and have hence learned from each other to eat dog's graſs, (agroſtis canina) when they are ſick, to promote vomiting. I have ſeen a cat miſtake the

blade of barley for this graſs, which evinces it is an acquired knowledge. They have alſo learnt of each other to cover their excrement and urine; about a ſpoonful of water was ſpilt upon my hearth from the tea-kettle, and I obſerved a kitten cover it with aſhes. Hence this muſt alſo be an acquired art, as the creature miſtook the application of it.

To preſerve their fur clean, and eſpecially their whiſkers, cats waſh their faces, and generally quite behind their ears, every time they eat. As they cannot lick thoſe places with their tongues, they firſt wet the inſide of the leg with ſaliva, and then repeatedly waſh their faces with it, which muſt originally be an effect of reaſoning, becauſe a means is uſed to produce an effect; and ſeems afterwards to be taught or acquired by imitation, like the greateſt part of human arts.

Theſe animals ſeem to poſſeſs ſomething like an additional ſenſe by means of their whiſkers; which have perhaps ſome analogy to the antennæ of moths and butterflies. The whiſkers of cats conſiſt not only of the long hairs on their upper lips, but they have alſo four or five long hairs ſtanding up from each eyebrow, and alſo two or three on each cheek; all which, when the animal erects them, make with their points ſo many parts of the periphery of a circle, of an extent at leaſt equal to the circumference of any part of their own bodies. With this inſtrument, I conceive, by a little experience, they can at once determine, whether any aperture amongſt hedges or ſhrubs, in which animals of this genus live in their wild ſtate, is large enough to admit their bodies; which to them is a matter of the greateſt conſequence, whether purſuing or purſued. They have likewiſe a power of erecting and bringing forward the whiſkers on their lips; which probably is for the purpoſe of feeling, whether a dark hole be further permeable.

The

The antennæ, or horns, of butterflies and moths, who have awkward wings, the minute feathers of which are very liable to injury, ſerve, I ſuppoſe, a ſimilar purpoſe of meaſuring, as they fly or creep amongſt the leaves of plants or trees, whither their wings can paſs without touching them.

Mr. Leonard, a very intelligent friend of mine, ſaw a cat catch a trout by darting upon it in a deep clear water at the mill at Weaford, near Lichfield. The cat belonged to Mr. Stanley, who had often ſeen her catch fiſh in the ſame manner in ſummer, when the mill-pool was drawn ſo low, that the fiſh could be ſeen. I have heard of other cats taking fiſh in ſhallow water, as they ſtood on the bank. This ſeems a natural art of taking their prey in cats, which their acquired delicacy by domeſtication has in general prevented them from uſing, though their deſire of eating fiſh continues in its original ſtrength.

Mr. White, in his ingenious Hiſtory of Selbourn, was witneſs to a cat's ſuckling a young hare, which followed her about the garden, and came jumping to her call of affection. At Elford near Lichfield, the Rev. Mr. Sawley had taken the young ones out of a hare, which was ſhot; they were alive, and the cat, who had juſt loſt her own kittens, carried them away, as it was ſuppoſed, to eat them; but it preſently appeared, that it was affection not hunger which incited her, as ſhe ſuckled them, and brought them up as their mother.

Other inſtances of the miſtaken application of what has been termed inſtinct may be obſerved in flies in the night, who miſtaking a candle for daylight, approach and periſh in the flame. So the putrid ſmell of the ſtapelia, or carrion-flower, allures the large fleſh-fly to depoſit its young worms on its beautiful petals, which periſh there for want of nouriſhment. This therefore cannot be a neceſſary

inſtinct

inſtinct, becauſe the creature miſtakes the application of it.

Though in this country horſes ſhew little veſtiges of policy, yet in the deſarts of Tartary, and Siberia, when hunted by the Tartars they are ſeen to form a kind of community, ſet watches to prevent their being ſurpriſed, and have commanders, who direct, and haſten their flight, Origin of Language, Vol. I. p. 212. In this country, where four or five horſes travel in a line, the firſt always points his ears forward, and the laſt points his backward, while the intermediate ones ſeem quite careleſs in this reſpect; which ſeems a part of policy to prevent ſurpriſe. As all animals depend moſt on the ear to apprize them of the approach of danger, the eye taking in only half the horizon at once, and horſes poſſeſs a great nicety of this ſenſe; as appears from their mode of fighting mentioned No. 8. 5. of this Section, as well as by common obſervation.

There are ſome parts of a horſe, which he cannot conveniently rub, when they itch, as about the ſhoulder, which he can neither bite with his teeth, nor ſcratch with his hind foot; when this part itches, he goes to another horſe, and gently bites him in the part which he wiſhes to be bitten, which is immediately done by his intelligent friend. I once obſerved a young foal thus bite its large mother, who did not chooſe to drop the graſs ſhe had in her mouth, and rubbed her noſe againſt the foal's neck inſtead of biting it; which evinces that ſhe knew the deſign of her progeny, and was not governed by a neceſſary inſtinct to bite where ſhe was bitten.

Many of our ſhrubs, which would otherwiſe afford an agreeable food to horſes, are armed with thorns or prickles, which ſecure them from thoſe animals; as the holly, hawthorn, gooſeberry, gorſe. In the extenſive moorlands of Staffordſhire, the horſes

horſes have learnt to ſtamp upon a gorſe-buſh with one of their fore-feet for a minute together, and when the points are broken, they eat it without injury. The horſes in the new foreſt in Hampſhire are affirmed to do the ſame by Mr. Gilpin. Foreſt Scenery, II. 251, and 112. Which is an art other horſes in the fertile parts of the country do not poſſeſs, and prick their months till they bleed, if they are induced by hunger or caprice to attempt eating gorſe.

Swine have a ſenſe of touch as well as of ſmell at the end of their noſe, which they uſe as a hand, both to root up the ſoil, and to turn over and examine objects of food, ſomewhat like the proboſcis of an elephant. As they require ſhelter from the cold in this climate, they have learnt to collect ſtraw in their mouths to make their neſt, when the wind blows cold; and to call their companions by repeated cries to aſſiſt in the work, and add to their warmth by their numerous bed-fellows. Hence theſe animals, which are eſteemed ſo unclean, have alſo learned never to befoul their dens, where they have liberty, with their own excrement; an art, which cows and horſes, which have open hovels to run into, have never acquired. I have obſerved great ſagacity in ſwine; but the ſhort lives we allow them, and their general confinement, prevents their improvement, which might probably be otherwiſe greater than that of dogs.

Inſtances of the ſagacity and knowledge of animals are very numerous to every obſerver, and their docility in learning various arts from mankind, evinces that they may learn ſimilar arts from their own ſpecies, and thus be poſſeſſed of much acquired and traditional knowledge.

A dog whoſe natural prey is ſheep, is taught by mankind, not only to leave them unmoleſted, but

to guard them; and to hunt, to ſet, or to deſtroy other kinds of animals, as birds, or vermin; and in ſome countries to catch fiſh, in others to find truffles, and to practiſe a great variety of tricks; is it more ſurpriſing that the crows ſhould teach each other, that the hawk can catch leſs birds, by the ſuperior ſwiftneſs of his wing, and if two of them follow him, till he ſucceeds in his deſign, that they can by force ſhare a part of the capture? This I have formerly obſerved with attention and aſtoniſhment.

There is one kind of pelican mentioned by Mr. Oſbeck, one of Linnæus's travelling pupils (the pelicanus aquilus), whoſe food is fiſh; and which it takes from other birds, becauſe it is not formed to catch them itſelf; hence it is called by the Engliſh a Man-of-war-bird, Voyage to China, p. 88. There are many other intereſting anecdotes of the pelican and cormorant, collected from authors of the beſt authority, in a well-managed Natural Hiſtory for Children, publiſhed by Mr. Galton. Johnſon. London.

And the following narration from the very accurate Monſ. Adanſon, in his Voyage to Senegal, may gain credit with the reader: as his employment in this country was ſolely to make obſervations in natural hiſtory. On the river Niger, in his road to the iſland Griel, he ſaw a great number of pelicans, or wide throats. "They moved with great ſtate like ſwans upon the water, and are the largeſt bird next to the oſtrich; the bill of the one I killed was upwards of a foot and half long, and the bag faſtened underneath it held two and twenty pints of water. They ſwim in flocks, and form a large circle, which they contract afterwards, driving the fiſh before them with their legs: when they ſee the fiſh in ſufficient number confined in this

ſpace,

ſpace, they plunge their bill wide open into the water, and ſhut it again with great quickneſs. They thus get fiſh into their throat-bag, which they eat afterwards on ſhore at their leiſure." P. 247.

XII. The knowledge and language of thoſe birds, that frequently change their climate with the ſeaſons, is ſtill more extenſive: as they perform theſe migrations in large ſocieties, and are leſs ſubject to the power of man, than the reſident tribes of birds. They are ſaid to follow a leader during the day, who is occaſionally changed, and to keep a continual cry during the night to keep themſelves together. It is probable that theſe emigrations were at firſt undertaken as accident directed, by the more adventurous of their ſpecies, and learned from one another like the diſcoveries of mankind in navigation. The following circumſtances ſtrongly ſupport this opinion.

1. Nature has provided theſe animals, in the climates where they are produced, with another reſource: when the ſeaſon becomes too cold for their conſtitutions, or the food they were ſupported with ceaſes to be ſupplied, I mean that of ſleeping. Dormice, ſnakes, and bats, have not the means of changing their country; the two former from the want of wings, and the latter from his being not able to bear the light of the day. Hence theſe animals are obliged to make uſe of this reſource, and ſleep during the winter. And thoſe ſwallows that have been hatched too late in the year to acquire their full ſtrength of pinion, or that have been maimed by accident of diſeaſe, have been frequently found in the hollows of rocks on the ſea coaſts, and even under water in this torpid ſtate, from which they have been revived by the warmth of a fire. This torpid ſtate of ſwallows is teſtified by innumerable evidences both of antient and modern

names. Ariſtotle ſpeaking of the ſwallows ſays, "They paſs into warmer climates in winter, if ſuch places are at no great diſtance; if they are, they bury themſelves in the climates where they dwell," (8. Hiſt. c. 16. See alſo Derham's Phyſ. Theol. v. ii. p. 177.)

Hence their emigrations cannot depend on a *neceſſary* inſtinct, as the emigrations themſelves are not *neceſſary!*

2. When the weather becomes cold, the ſwallows in the neighbourhood aſſemble in large flocks; that is, the unexperienced attend thoſe that have before experienced the journey they are about to undertake: they are then ſeen ſome times to hover on the coaſt, till there is calm weather, or a wind, that ſuits the direction of their flight. Other birds of paſſage have been drowned by thouſands in the ſea, or have ſettled on ſhips quite exhauſted with fatigue. And others, either by miſtaking their courſe, or by diſtreſs of weather, have arrived in countries where they were never ſeen before, and thus are evidently ſubject to the ſame hazards that the human ſpecies undergo, in the execution of their artificial purpoſes.

3. The ſame birds are emigrant from ſome countries and not ſo from others: the ſwallows were ſeen at Goree in January by an ingenious philoſopher of my acquaintance, and he was told that they continued there all the year; as the warmth of the climate was at all ſeaſons ſufficient for their own conſtitutions, and for the production of the flies that ſupply them with nouriſhment. Herodotus ſays, that in Lybia, about the ſprings of the Nile, the ſwallows continue all the year. (L. 2.)

Quails (tetrao corturnix, Lin.) are birds of paſſage from the coaſt of Barbary to Italy, and have frequently ſettled in large ſhoals on ſhips, fatigued with their flight. (Ray, Wiſdom of God, p. 129.

Derham

Derham Phyſic. Theol. v. ii. p. 178.) Dr. Ruſſel, in his Hiſtory of Aleppo, obſerves that the ſwallows viſit that country about the end of February, and having hatched their young diſappear about the end of July; and returning again about the beginning of October, continue about a fortnight, and then again diſappear. (P. 70.)

When my late friend Dr. Chambres, of Derby, was on the iſland of Caprea in the bay of Naples, he was informed that great flights of quails annually ſettle on that iſland about the beginning of May, in their paſſage from Africa to Europe. And that they always come when the ſouth-eaſt wind blows, are fatigued when they reſt on this iſland, and are taken in ſuch amazing quantities and ſold to the Continent, that the inhabitants pay the biſhop his ſtipend out of the profits ariſing from the ſale of them.

The flights of theſe birds acroſs the Mediterranean are recorded near three thouſand years ago. "There went forth a wind from the Lord and brought quails from the ſea, and let them fall upon the camp, a day's journey round about it, and they were two cubits above the earth," (Numbers, chap. ii. ver. 31.)

In our country, Mr. Pennant informs us, that ſome quails migrate, and others only remove from the internal parts of the iſland to the coaſts, (Zoology, octavo, 210.) Some of the ringdoves and ſtares breed here, others migrate, (ibid. 510, 511.) And the ſlender billed ſmall birds do not all quit theſe kingdoms in the winter, though the difficulty of procuring the worms and inſects, that they feed on, ſupplies the ſame reaſon for migration to them all, (ibid. 511.)

Linnæus has obſerved, that in Sweden the female chaffinches quit that country in September, migrating into Holland, and leave their mates behind till their

their return in ſpring. Hence he has called them Fringilla cœlebs, (Amæn. Acad. ii. 42. iv. 595.) Now in our climate both ſexes of them are perennial birds. And Mr. Pennant obſerves that the hoopoe, chatterer, hawfinch, and croſsbill, migrate into England ſo rarely, and at ſuch uncertain times, as not to deſerve to be ranked among our birds of paſſage, (ibid. 511.)

The water fowl, as geeſe and ducks, are better adapted for long migrations, than the other tribes of birds, as, when the weather is calm, they can not only reſt themſelves, or ſleep upon the ocean, but poſſibly procure ſome kind of food from it.

Hence in Siberia, as ſoon as the lakes are frozen, the water fowl, which are very numerous, all diſappear, and are ſuppoſed to fly to warmer climates, except the rail, which, from its inability for long flights, probably ſleeps, like our bat, in their winter. The following account from the Journey of Profeſſor Gmelin, may entertain the reader. "In the neighbourhood of Kraſnoiark, amongſt many other emigrant water fowls, we obſerved a great number of rails, which when purſued never took flight, but endeavoured to eſcape by running. We enquired how theſe birds, that could not fly, could retire into other countries in the winter, and were told, both by the Tartars and Aſſanians, that they well knew thoſe birds could not alone paſs into other countries: but when the cranes (les grues) retire in autumn, each one takes a rail (un rale) upon his back, and carries him to a warmer climate."

Recapitulation.

1. All birds of paſſage can exiſt in the climates, where they are produced.

2. They

2. They are ſubject in their migrations to the ſame accidents and difficulties, that mankind are ſubject to in navigation.

3. The ſame ſpecies of birds migrate from ſome countries, and are reſident in others.

From all theſe circumſtances it appears that the migrations of birds are not produced by a neceſſary inſtinct, but are accidental improvements, like the arts among mankind, taught by their cotemporaries, or delivered by tradition from one generation of them to another.

XIII. In the ſeaſon of the year which ſupplies the nouriſhment proper for the expected brood, the birds enter into a contract of marriage, and with joint labour conſtruct a bed for the reception of their offspring. Their choice of the proper ſeaſon, their contracts of marriage, and the regularity with which they conſtruct their neſts, have in all ages excited the admiration of naturaliſts; and have always been attributed to the power of inſtinct, which, like the occult qualities of the antient philoſophers, prevented all further enquiry. We ſhall conſider them in their order.

Their Choice of the Seaſon.

Our domeſtic birds, that are plentifully ſupplied throughout the year with their adapted food, and are covered with houſes from the inclemency of the weather, lay their eggs at any ſeaſon: which evinces that the ſpring of the year is not pointed out to them by a neceſſary inſtinct.

Whilſt the wild tribes of birds chooſe this time of the year from their acquired knowledge, that the mild temperature of the air is more convenient for hatching their eggs, and is ſoon likely to ſupply

that

that kind of nouriſhment that is wanted for their young.

If the genial warmth of the ſpring produced the paſſion of love, as it expands the foliage of trees, all other animals ſhould feel its influence as well as birds: but, the viviparous creatures, as they ſuckle their young, that is, as they previouſly digeſt the natural food, that it may better ſuit the tender ſtomachs of their offſpring, experience the influence of this paſſion at all ſeaſons of the year, as cats and bitches. The graminivorous animals indeed generally produce their young about the time when graſs is ſupplied in the greateſt plenty, but this is without any degree of exactneſs, as appears from our cows, ſheep, and hares, and may be a part of the traditional knowledge, which they learn from the example of the parents.

Their Contracts of Marriage.

Their mutual paſſion, and the acquired knowledge, that their joint labour is neceſſary to procure ſuſtenance for their numerous family, induces the wild birds to enter into a contract of marriage, which does not however take place among the ducks, geeſe, and fowls, that are provided with their daily food from our barns.

An ingenious philoſopher has lately denied, that animals can enter into contracts, and thinks this an eſſential difference between them and the human creature:—but does not daily obſervation convince us, that they form contracts of friendſhip with each other, and with mankind? When puppies and kittens play together, is there not a tacit contract, that they will not hurt each other? And does not your favorite dog expect you ſhould give him his daily food, for his ſervices and attention

to

to you? And thus barters his love for your protection? In the ſame manner that all contracts are made amongſt men, that do not underſtand each others' arbitrary language.

The Conſtruction of their Neſts.

1. They ſeem to be inſtructed how to build their neſts from their obſervation of that, in which they were educated, and from their knowledge of thoſe things, that are moſt agreeable to their touch in reſpect to warmth, cleanlineſs, and ſtability. They chooſe their ſituations from their ideas of ſafety from their enemies, and of ſhelter from the weather. Nor is the colour of their neſts a circumſtance unthought of; the finches, that build in green hedges, cover their habitations with green moſs; the ſwallow or martin, that builds againſt rocks and houſes, covers her's with clay, whilſt the lark chooſes vegetable ſtraw nearly of the colour of the ground ſhe inhabits: by this contrivance, they are all leſs liable to be diſcovered by their adverſaries.

2. Nor are the neſts of the ſame ſpecies of birds conſtructed always of the ſame materials, nor in the ſame form; which is another circumſtance that aſcertains, that they are led by obſervation.

In the trees before Mr. Levet's houſe in Lichfield, there are annually neſts built by ſparrows, a bird which uſually builds under the tiles of houſes, or the thatch of barns. Not finding ſuch convenient ſituations for their neſts, they build a covered neſt bigger than a man's head, with an opening like a mouth, at the ſide, reſembling that of a magpie, except that it is built with ſtraw and hay, and lined with feathers, and ſo nicely managed as to be a defence againſt both wind and rain.

The

The following extract from a Letter of the Rev. Mr. J. Darwin, of Carleton Scroop in Lincolnſhire, authenticates a curious fact of this kind. "When I mentioned to you the circumſtance of crows or rooks building in the ſpire of Welbourn church, you expreſſed a deſire of being well informed of the certainty of the fact. Welbourn is ſituated in the road from Grantham to Lincoln on the Cliff row; I yeſterday took a ride thither, and enquired of the rector, Mr. Ridgehill, whether the report was true, that rooks built in the ſpire of his church. He aſſured me it was true, and that they had done ſo time immemorial, as his pariſhioners affirmed. There was a common tradition, he ſaid, that formerly a rookery in ſome high trees adjoined the church yard, which being cut down (probably in the ſpring, the building ſeaſon), the rooks removed to the church, and built their neſts on the outſide of the ſpire on the tops of windows, which by their projection a little from the ſpire made them convenient room, but that they built alſo on the inſide. I ſaw two neſts made with ſticks on the outſide, and in the ſpires, and Mr. Ridgehill ſaid there were always a great many.

"I ſpent the day with Mr. Wright, a clergyman, at Fulbeck, near Welbourn, and in the afternoon Dr. Ellis of Headenham, about two miles from Welbourn, drank tea at Mr. Wright's, who ſaid he remembered, when Mr. Welby lived at Welbourn, that he received a letter from an acquaintance in the weſt of England, deſiring an anſwer, whether the report of rooks building in Welbourn church was true, as a wager was depending on that ſubject: to which he returned an anſwer aſcertaining the fact, and decided the wager." Aug. 30, 1794.

So the jackdaw (corvus monedula) generally builds in church-ſteeples, or under the roofs of high houſes; but at Selbourn, in Southamptonſhire, where towers and ſteeples are not ſufficiently numerous,

merous, these birds build in forsaken rabbit burrows. See a curious account of these subterranean nests in White's History of Selbourn, p. 50. Can the skilful change of architecture in these birds and the sparrows above mentioned be governed by instinct? Then they must have two instincts, one for common, and the other for extraordinary occasions.

I have seen green worsted in a nest, which no where exists in nature: and the down of thistles in those nests, that were by some accident constructed later in the summer, which material could not be procured for the earlier nests: in many different climates they cannot procure the same materials, that they use in ours. And it is well known, that the canary birds, that are propagated in this country, and the finches, that are kept tame, will build their nests of any flexile materials, that are given them. Plutarch, in his Book on Rivers, speaking of the Nile, says, "that the swallows collect a material, when the waters recede, with which they form nests, that are impervious to water." And in India there is a swallow that collects a glutinous substance for this purpose, whose nest is esculent, and esteemed a principal rarity amongst epicures, (Lin. Syst. Nat.) Both these must be constructed of very different materials from those used by the swallows of our country.

In India the birds exert more artifice in building their nests on account of the monkeys and snakes: some form their pensile nests in the shape of a purse, deep and open at top; others with a hole in the side; and others, still more cautious, with an entrance at the very bottom, forming their lodge near the summit. But the taylor-bird will not ever trust its nest to the extremity of a tender twig, but makes one more advance to safety by fixing it to the leaf itself. It picks up a dead leaf, and sews

it to the ſide of a living one, its ſlender bill being its needle, and its thread ſome fine fibres; the lining conſiſts of feathers, goſſamer, and down; its eggs are white, the colour of the bird light yellow, its length three inches, its weight three ſixteenths of an ounce; ſo that the materials of the neſt, and the weight of the bird, are not likely to draw down an habitation ſo ſlightly ſuſpended. A neſt of this bird is preſerved in the Britiſh Muſeum, (Pennant's Indian Zoology). This calls to one's mind the Moſaic account of the origin of mankind, the firſt dawning of art there aſcribed to them, is that of ſewing leaves together. For many other curious kinds of neſts ſee Natural Hiſtory for Children, by Mr. Galton. Johnſon. London. Part I. p. 47. Gen. Oriolus.

3. Thoſe birds that are brought up by our care, and have had little communication with others of their own ſpecies, are very defective in this acquired knowledge; they are not only very awkward in the conſtruction of their neſts, but generally ſcatter their eggs in various parts of the room or cage, where they are confined, and ſeldom produce young ones, till, by failing in their firſt attempt, they have learnt ſomething from their own obſervation.

4. During the time of incubation birds are ſaid in general to turn their eggs every day; ſome cover them, when they leave the neſt, as ducks and geeſe; in ſome the male is ſaid to bring food to the female, that ſhe may have leſs occaſion of abſence, in others he is ſaid to take her place, when ſhe goes in queſt of food; and all of them are ſaid to leave their eggs a ſhorter time in cold weather than in warm. In Senegal the oſtrich ſits on her eggs only during the night, leaving them in the day to the heat of the ſun; but at the Cape of Good Hope, where the heat is leſs, ſhe ſits on them day and night.

If

If it ſhould be aſked, what induces a bird to ſit weeks on its firſt eggs unconſcious that a brood of young ones will be the product? The anſwer muſt be, that it is the ſame paſſion that induces the human mother to hold her offspring whole nights and days in her fond arms, and preſs it to her boſom, unconſcious of its future growth to ſenſe and manhood, till obſervation or tradition have informed her.

5. And as many ladies are too refined to nurſe their own children, and deliver them to the care and proviſion of others; ſo is there one inſtance of this vice in the feathered world. The cuckoo in ſome parts of England, as I am well informed by a very diſtinct and ingenious gentleman, hatches and educates her own young; whilſt in other parts ſhe builds no neſt, but uſes that of ſome leſſer bird, generally either of the wagtail, or hedge ſparrow, and depoſiting one egg in it, takes no further care of her progeny.

As the Rev. Mr. Stafford was walking in Gloſop Dale, in the Peak of Derbyſhire, he ſaw a cuckoo riſe from its neſt. The neſt was on the ſtump of a tree, that had been ſome time felled, among ſome chips that were in part turned grey, ſo as much to reſemble the colour of the bird, in this neſt were two young cuckoos: tying a ſtring about the leg of one of them, he pegged the other end of it to the ground, and very frequently for many days beheld the old cuckoo feed theſe her young, as he ſtood very near them.

The following extract of a Letter from the Rev. Mr. Wilmot, of Morley, near Derby, ſtrengthens the truth of the fact above mentioned, of the cuckoo ſometimes making a neſt, and hatching her own young.

"In the beginning of July, 1792, I was attending ſome labourers on my farm, when one of them

ſaid to me, "There is a bird's neſt upon one of the Coal ſlack Hills; the bird is now ſitting, and is exactly like a cuckoo. They ſay that cuckoos never hatch their own eggs, otherwiſe I ſhould have ſworn it was one." He took me to the ſpot, it was in an open fallow ground; the bird was upon the neſt, I ſtood and obſerved her ſome time, and was perfectly ſatisfied it was a cuckoo; I then put my hand towards her, and ſhe almoſt let me touch her before ſhe roſe from the neſt, which ſhe appeared to quit with great uneaſineſs, ſkimming over the ground in the manner that a hen partridge does when diſturbed from a new hatched brood, and went only to a thicket about forty or fifty yards from the neſt; and continued there as long as I ſtaid to obſerve her, which was not many minutes. In the neſt, which was barely a hole ſcratched out of the coal-ſlack in the manner of a plover's neſt, I obſerved three eggs, but did not touch them. As I had labourers conſtantly at work in that field, I went thither every day, and always looked to ſee if the bird was there, but did not diſturb her for ſeven or eight days, when I was tempted to drive her from the neſt, and found *two* young ones, that appeared to have been hatched ſome days, but there was no appearance of the third egg. I then mentioned this extraordinary circumſtance (for ſuch I thought it) to Mr. and Mrs. Holyoak of Bidford Grange, Warwickſhire, and to Miſs M. Willes, who were on a viſit at my houſe, and who all went to ſee it. Very lately I reminded Mr. Holyoak of it, who told me he had a perfect recollection of the whole, and that, conſidering it a curioſity, he walked to look at it ſeveral times, was perfectly ſatisfied as to its being a cuckoo, and thought her more attentive to her young, than any other bird he ever obſerved, having always found her brooding her young. In about a week after I firſt ſaw the young ones, one of them was miſſing, and I rather ſuſpected my plough-boys having taken it; though it might

might poſſibly have been taken by a hawk, ſome time when the old one was ſeeking food. I never found her off her neſt but once, and that was the laſt time I ſaw the remaining young one, when it was almoſt full feathered. I then went from home for two or three days, and, when I returned, the young one was gone, which I take for granted had flown. Though during this time I frequently ſaw cuckoos in the thicket I mention, I never obſerved any one, that I ſuppoſed to be the cock-bird, paired with this hen."

Nor is this a new obſervation, though it is entirely overlooked by the modern naturaliſts, for Ariſtotle ſpeaking of the cuckoo, aſſerts that ſhe ſometimes builds her neſt among broken rocks, and on high mountains, (L. 6. H. c. 1.) but adds in another place that ſhe generally poſſeſſes the neſt of another bird, (L. 6. H. c. 7.) And Niphus ſays that cuckoos rarely build for themſelves, moſt frequently laying their eggs in the neſts of other birds, (Geſner, L. 3. de Cuculo.)

The Philoſopher who is acquainted with theſe facts concerning the cuckoo, would ſeem to have very little *reaſon* himſelf, if he could imagine this neglect of her young to be a neceſſary *inſtinct!*

XIV. The deep receſſes of the ocean are inacceſſible to mankind, which prevents us from having much knowledge of the arts and government of its inhabitants.

1. One of the baits uſed by the fiſherman, is an animal called an Old Soldier, his ſize and form are ſomewhat like the craw-fiſh, with this difference, that his tail is covered with a tough membrane inſtead of a ſhell; and to obviate this defect, he ſeeks out the uninhabited ſhell of ſome dead fiſh, that is large enough to receive his tail, and carries it about with him as part of his clothing or armour.

2. On

2. On the coaſts about Scarborough, where the haddocks, cods, and dog-fiſh, are in great abundance, the fiſhermen univerſally believe that the dog-fiſh make a line, or ſemicircle, to encompaſs a ſhoal of haddocks and cod, confining them within certain limits near the ſhore, and eating them as occaſion requires. For the haddocks and cods are always found near the ſhore without any dog-fiſh among them, and the dog-fiſh further off without any haddocks or cod; and yet the former are known to prey upon the latter, and in ſome years devour ſuch immenſe quantities as to render this fiſhery more expenſive than profitable.

3. The remora, when he wiſhes to remove his ſituation, as he is a very ſlow ſwimmer, is content to take an outſide place on whatever conveyance is going his way; nor can the cunning animal be tempted to quit his hold of a ſhip when ſhe is ſailing, not even for the lucre of a piece of pork, leſt it ſhould endanger the loſs of his paſſage: at other times he is eaſily caught with the hook.

4. The crab-fiſh, like many other teſtaceous animals, annually changes its ſhell; it is then in a ſoft ſtate, covered only with a mucous membrane, and conceals itſelf in holes in the ſand or under weeds; at this place a hard ſhelled crab always ſtands centinel, to prevent the ſea inſects from injuring the other in its defenceleſs ſtate; and the fiſhermen from his appearance know where to find the ſoft ones, which they uſe for baits in catching other fiſh.

And though the hard ſhelled crab, when he is on this duty, advances boldly to meet the foe, and will with difficulty quit the field; yet at other times he ſhews great timidity, and has a wonderful ſpeed in attempting his eſcape; and, if often interrupted, will pretend death like the ſpider, and watch an opportunity to ſink himſelf into the ſand, keeping

keeping only his eyes above. My ingenious friend Mr. Burdett, who favoured me with theſe accounts at the time he was ſurveying the coaſts, thinks the commerce between the ſexes takes place at this time, and inſpires the courage of the creature.

5. The ſhoals of herrings, cods, haddocks, and other fiſh, which approach our ſhores at certain ſeaſons, and quit them at other ſeaſons without leaving one behind; and the ſalmon, that periodically frequent our rivers, evince, that there are vagrant tribes of fiſh, that perform as regular migrations as the birds of paſſage already mentioned.

6. There is a cataract on the river Liffey in Ireland about nineteen feet high: here in the ſalmon ſeaſon many of the inhabitants amuſe themſelves in obſerving theſe fiſh leap up the torrent. They dart themſelves quite out of the water as they aſcend, and frequently fall back many times before they ſurmount it, and baſkets made of twigs are placed near the edge of the ſtream to catch them in their fall.

I have obſerved, as I have ſat by a ſpout of water, which deſcends from a ſtone trough about two feet into a ſtream below, at particular ſeaſons of the year, a great number of little fiſh called minums, or pinks, throw themſelves about twenty times their own length out of the water, expecting to get into the trough above.

This evinces that the ſtorgee, or attention of the dam to provide for the offſpring, is ſtrongly exerted amongſt the nations of fiſh, where it would ſeem to be the moſt neglected; as theſe ſalmon cannot be ſuppoſed to attempt ſo difficult and dangerous a taſk without being conſcious of the purpoſe or end of their endeavours.

It is further remarkable, that moſt of the old ſalmon return to the ſea before it is proper for the young ſhoals to attend them, yet that a few old ones

continue

continue in the rivers ſo late, that they become perfectly emaciated by the inconvenience of their ſituation, and this apparently to guide or to protect the unexperienced brood.

Of the ſmaller water animals we have ſtill leſs knowledge, who nevertheleſs probably poſſeſs many ſuperior arts; ſome of theſe are mentioned in Botanic Garden, P. I. Add. Note XXVII. and XXVIII. The nympha of the water-moths of our rivers, which cover themſelves with caſes of ſtraw, gravel, and ſhell, contrive to make their habitations nearly in equilibrium with the water; when too heavy, they add a bit of wood or ſtraw; when too light, a bit of gravel. Edinb. Tranſ.

All theſe circumſtances bear a near reſemblance to the deliberate actions of human reaſon.

XV. We have a very imperfect acquaintance with the various tribes of inſects: their occupations, manner of life, and even the number of their ſenſes, differ from our own, and from each other; but there is reaſon to imagine, that thoſe which poſſeſs the ſenſe of touch in the moſt exquiſite degree, and whoſe occupations require the moſt conſtant exertion of their powers, are indued with a greater proportion of knowledge and ingenuity.

The ſpiders of this country manufacture nets of various forms, adapted to various ſituations, to arreſt the flies that are their food; and ſome of them have a houſe or lodging place in the middle of the net, well contrived for warmth, ſecurity, or concealment. There is a large Spider in South America, who conſtructs nets of ſo ſtrong a texture as to entangle ſmall birds, particularly the humming bird. And in Jamaica there is another ſpider, who digs a hole in the earth obliquely downwards, about three inches in length, and one inch in diameter, this cavity ſhe lines with a tough thick web, which when taken out reſembles a leathern purſe: but

what

what is moſt curious, this houſe has a door with hinges, like the operculum of ſome ſea-ſhells; and herſelf and family, who tenant this neſt, open and ſhut the door, whenever they paſs or repaſs. This hiſtory was told me, and the neſt with its operculum ſhewn me by the late Dr. Butt of Bath, who was ſome years phyſician in Jamaica.

The production of theſe nets is indeed a part of the nature or conformation of the animal, and their natural uſe is to ſupply the place of wings, when ſhe wiſhes to remove to another ſituation. But when ſhe employs them to entangle her prey, there are marks of evident deſign, for ſhe adapts the form of each net to its ſituation, and ſtrengthens thoſe lines, that require it, by joining others to the middle of them, and attaching thoſe others to diſtant objects, with the ſame individual art, that is uſed by mankind in ſupporting the maſts and extending the ſails of ſhips. This work is executed with more mathematical exactneſs and ingenuity by the field ſpiders, than by thoſe in our houſes, as their conſtructions are more ſubjected to the injuries of dews and tempeſts.

Beſides the ingenuity ſhewn by theſe little creatures in taking their prey, the circumſtance of their counterfeiting death, when they are put into terror, is truly wonderful; and as ſoon as the object of terror is removed, they recover and run away. Some beetles are alſo ſaid to poſſeſs this piece of hypocriſy.

The curious webs, or chords, conſtructed by ſome young caterpillars to defend themſelves from cold, or from inſects of prey; and by ſilk-worms and ſome other caterpillars, when they tranſmigrate into aureliæ or larvæ, have deſervedly excited the admiration of the inquiſitive. But our ignorance of their manner of life, and even of the number of their ſenſes, totally precludes us from underſtanding

ing the means by which they acquire this knowledge.

The care of the ſalmon in chooſing a proper ſituation for her ſpawn, the ſtructure of the neſts of birds, their patient incubation, and the art of the cuckoo in depoſiting her egg in her neighbour's nurſery, are inſtances of great ſagacity in thoſe creatures: and yet they are much inferior to the arts exerted by many of the inſect tribes on ſimilar occaſions. The hairy excreſcences on briars, the oak apples, the blaſted leaves of trees, and the lumps on the backs of cows, are ſituations that are rather produced than choſen by the mother inſect for the convenience of her offspring. The cells of bees, waſps, ſpiders, and of the various coralline inſects, equally aſtoniſh us, whether we attend to the materials or to the architecture.

But the conduct of the ant, and of ſome ſpecies of the ichneumon fly in the incubation of their eggs, is equal to any exertion of human ſcience. The ants many times in a day move their eggs nearer the ſurface of their habitation, or deeper below it, as the heat of the weather varies; and in colder days lie upon them in heaps for the purpoſe of incubation: if their manſion is too dry, they carry them to places where there is moiſture, and you may diſtinctly ſee the little worms move and ſuck up the water. When too much moiſture approaches their neſt, they convey their eggs deeper in the earth, or to ſome other place of ſafety. (Swammerd. Epiſ. ad Hiſt. Inſects, p. 153. Phil. Tranſ. No. 23. Lowthorp, V. 2. p. 7.)

There is one ſpecies of ichneumon-fly, that digs a hole in the earth, and carrying into it two or three living caterpillars, depoſits her eggs, and nicely cloſing up the neſt leaves them there; partly doubtleſs to aſſiſt the incubation, and partly to ſupply food

food to her future young, (Derham. B. 4. c. 13. Ariſtotle Hiſt. Animal, L. 5. c. 20.)

A friend of mine put about fifty large caterpillars collected from cabbages on ſome bran and a few leaves into a box, and covered it with gauze to prevent their eſcape. After a few days we ſaw, from more than three fourths of them, about eight or ten little caterpillars of the ichneumon-fly come out of their backs, and ſpin each a ſmall cocoon of ſilk, and in a few days the large caterpillars died. This ſmall fly it ſeems lays its egg in the back of the cabbage caterpillar, which when hatched preys upon the material, which is produced there for the purpoſe of making ſilk for the future neſt of the cabbage caterpillar; of which being deprived, the creature wanders about till it dies, and thus our gardens are preſerved by the ingenuity of this cruel fly. This curious property of producing a ſilk thread, which is common to ſome ſea animals, ſee Botanic Garden, Part I. Note XXVII. and is deſigned for the purpoſe of their transformation as in the ſilk-worm, is uſed for conveying themſelves from higher branches to lower ones of trees by ſome caterpillars, and to make themſelves temporary neſts or tents, and by the ſpider for entangling his prey. Nor is it ſtrange that ſo much knowledge ſhould be acquired by ſuch ſmall animals; ſince there is reaſon to imagine, that theſe inſects have the ſenſe of touch, either in their proboſcis, or their antennæ, to a great degree of perfection; and thence may poſſeſs, as far as their ſphere extends, as accurate knowledge, and ſubtile invention, as the diſcoverers of human arts.

XVI. 1. If we were better acquainted with the hiſtories of thoſe inſects that are formed into ſocieties, as the bees, waſps, and ants, I make no doubt but we ſhould find, that their arts and improvements are not ſo ſimilar and uniform as they now

now appear to us, but that they aroſe in the ſame manner from experience and tradition, as the arts of our own ſpecies; though their reaſoning is from fewer ideas, is buſied about fewer objects, and is exerted with leſs energy.

There are ſome kinds of inſects that migrate like the birds before mentioned. The locuſt of warmer climates has ſometimes come over to England; it is ſhaped like a graſshopper, with very large wings, and a body above an inch in length. It is mentioned as coming into Egypt with an eaſt wind, "The Lord brought an eaſt wind upon the land all that day and night, and in the morning the eaſt wind brought the locuſts, and covered the face of the earth, ſo that the land was dark," Exod. x. 13. The migrations of theſe inſects are mentioned in another part of the ſcripture, "The locuſts have no king, yet go they forth all them in bands," Prov. xxx. 27.

The accurate Mr. Adanſon, near the river Gambia in Africa, was witneſs to the migration of theſe inſects. "About eight in the morning, in the month of February, there ſuddenly aroſe over our heads a thick cloud, which darkened the air, and deprived us of the rays of the ſun. We found it was a cloud of locuſts raiſed about twenty or thirty fathoms from the ground, and covering an extent of ſeveral leagues; at length a ſhower of theſe inſects deſcended, and after devouring every green herb, while they reſted, again reſumed their flight. This cloud was brought by a ſtrong eaſt-wind, and was all the morning in paſſing over the adjacent country." (Voyage to Senegal, 158)

In this country the gnats are ſometimes ſeen to migrate in clouds, like the muſketoes of warmer climates, and our ſwarms of bees frequently travel many miles, and are ſaid in North America always to fly towards the ſouth. The prophet Iſaiah has a beautiful

beautiful alluſion to theſe migrations, "The Lord ſhall call the fly from the rivers of Egypt, and ſhall hiſs for the bee that is in the land of Aſſyria," Iſa. vii. 18. which has been lately explained by Mr. Bruce, in his travels to diſcover the ſource of the Nile.

2. I am well informed that the bees that were carried into Barbadoes, and other weſtern iſlands, ceaſed to lay up any honey after the firſt year, as they found it not uſeful to them: and are now become very troubleſome to the inhabitants of thoſe iſlands by infeſting their ſugar-houſes; but thoſe in Jamaica continue to make honey, as the cold north winds, or rainy ſeaſons of that iſland, confine them at home for ſeveral weeks together. And the bees of Senegal, which differ from thoſe of Europe only in ſize, make their honey not only ſuperior to ours in delicacy of flavour, but it has this ſingularity, that it never concretes, but remains liquid as ſyrup, (Adanſon). From ſome obſervations of Mr. Wildman and of other people of veracity, it appears, that during the ſevere part of the winter ſeaſon for weeks together the bees are quite benumbed and torpid from the cold, and do not conſume any of their proviſion. This ſtate of ſleep, like that of ſwallows and bats, ſeems to be the natural reſource of thoſe creatures in cold climates, and the making of honey to be an artificial improvement.

As the death of our hives of bees appears to be owing to their being kept ſo warm, as to require food when their ſtock is exhauſted; a very obſerving gentleman at my requeſt put two hives for many weeks into a dry cellar, and obſerved, during all that time, they did not conſume any of their proviſion, for their weight did not decreaſe, as it had done when they were kept in the open air. The ſame obſervation is made in the Annual Regiſter for 1768. p. 113. And the Rev. Mr. White, in his

Method

Method of preſerving Bees, adds, that thoſe on the north ſide of his houſe conſumed leſs honey in the winter than thoſe on the ſouth ſide.

There is another obſervation on bees well aſcertained, that they at various times, when the ſeaſon begins to be cold, by a general motion of their legs as they hang in cluſters produce a degree of warmth, which is eaſily perceptible by the hand. Hence by this ingenious exertion, they for a long time prevent the torpid ſtate they would naturally fall into.

According to the late obſervations of Mr. Hunter, it appears that the bees-wax is not made from the duſt of the anthers of flowers, which they bring home on their thighs, but that this makes what is termed bee-bread, and is uſed for the purpoſe of feeding the bee-maggots; in the ſame manner butterflies live on honey, but the previous caterpillar lives on vegetable leaves, while the maggots of large flies require fleſh for their food, and thoſe of the ichneumon fly require inſects for their food. What induces the bee who lives on honey to lay up vegetable powder for its young? What induces the butterfly to lay its eggs on leaves, when itſelf feeds on honey? What induces the other flies to ſeek a food for their progeny different from what they conſume themſelves? If theſe are not deductions from their own previous experience or obſervation, all the actions of mankind muſt be reſolved into inſtinct.

3. The dormouſe conſumes but little of its food during the rigour of the ſeaſon, for they roll themſelves up, or ſleep, or lie torpid the greateſt part of the time; but on warm ſunny days experience a ſhort revival, and take a little food, and then relapſe into their former ſtate." (Pennant Zoolog. p. 67.) Other animals, that ſleep in winter without laying up any provender, are obſerved to go into

into their winter beds fat and ſtrong, but return to day-light in the ſpring ſeaſon very lean and feeble. The common flies ſleep during the winter without any proviſion for their nouriſhment, and are daily revived by the warmth of the ſun, or of our fires. Theſe whenever they ſee light endeavour to approach it, having obſerved, that by its greater vicinity they get free from the degree of torpor that the cold produces; and are hence induced perpetually to burn themſelves in our candles: deceived, like mankind, by the miſapplication of their knowledge. Whilſt many of the ſubterraneous inſects, as the common worms, ſeem to retreat ſo deep into the earth as not to be enlivened or awakened by the difference of our winter days; and ſtop up their holes with leaves or ſtraws, to prevent the froſts from injuring them, or the centipes from devouring them. The habits of peace, or the ſtratagems of war, of theſe ſubterranean nations are covered from our view; but a friend of mine prevailed on a diſtreſſed worm to enter the hole of another worm on a bowling-green, and he preſently returned much wounded about his head. And I once ſaw a worm riſe haſtily out of the earth into the ſunſhine, and obſerved a centipes hanging at its tail; the centipes nimbly quitted the tail, and ſeizing the worm about its middle, cut it in half with its forceps, and preyed upon one part, while the other eſcaped. Which evinces they have deſign in ſtopping the mouths of their habitations.

4. The waſp of this country fixes his habitation under ground, that he may not be affected with the various changes of our climate; but in Jamaica he hangs it on the bough of a tree, where the ſeaſons are leſs ſevere. He weaves a very curious paper of vegetable fibres to cover his neſt, which is conſtructed on the ſame principle with that of the bee, but with a different material; but as his prey conſiſts

ſiſts of fleſh, fruits, and inſects, which are periſhable commodities, he can lay up no provender for the winter.

M. de Loubiere, in his relation of Siam, ſays, "That in a part of that kingdom, which lies open to great inundations, all the ants make their ſettlements upon trees; no ants' neſts are to be ſeen any where elſe." Whereas in our country the ground is their only ſituation. From the ſcriptural account of theſe inſects, one might be led to ſuſpect, that in ſome climates they lay up a proviſion for the winter. Origen affirms the ſame, (Cont. Celſ. L. 4.) But it is generally believed that in this country they do not, (Prov. vi. 6. xxx. 25.) The white ants of the coaſt of Africa make themſelves pyramids eight or ten feet high, on a baſe of about the ſame width, with a ſmooth ſurface of rich clay, exceſſively hard and well built, which appear at at a diſtance like an aſſemblage of the huts of the negroes, (Adanſon.) The hiſtory of theſe has been lately well deſcribed in the Philoſoph. Tranſactions, under the name of termes, or termites. Theſe differ very much from the neſt of our large ant; but the real hiſtory of this creature, as well as of the waſp, is yet very imperfectly known.

Waſps are ſaid to catch large ſpiders, and to cut off their legs, and carry their mutilated bodies to their young, Dict. Raiſon. Tom. I. p. 152.

One circumſtance I ſhall relate which fell under my own eye, and ſhewed the power of reaſon in a waſp, as is it exerciſed among men. A waſp, on a gravel walk, had caught a fly nearly as large as himſelf; kneeling on the ground I obſerved him ſeparate the tail and the head from the body part, to which the wings were attached. He then took the body part in his paws, and roſe about two feet from the ground with it; but a gentle breeze wafting the wings of the fly turned him round in the air,

air, and he ſettled again with his prey upon the gravel. I then diſtinctly obſerved him cut off with his mouth, firſt one of the wings, and then the other, after which he flew away with it unmoleſted by the wind.

Go, thou ſluggard, learn arts and induſtry from the bee, and from the ant!

Go proud reaſoner, and call the worm thy ſiſter!

XVII *Concluſion.*

It was before obſerved how much the ſuperior accuracy of our ſenſe of touch contributes to increaſe our knowledge; but it is the greater energy and activity of the power of volition (as explained in the former Sections of this work) that marks mankind, and has given him the empire of the world.

There is a criterion by which we may diſtinguiſh our voluntary acts or thoughts from thoſe that are excited by our ſenſations: "The former are always employed about the *means* to acquire pleaſurable objects, or to avoid painful ones: while the latter are employed about the *poſſeſſion* of thoſe that are already in our power."

If we turn our eyes upon the fabric of our fellow animals, we find they are ſupported with bones, covered with ſkins, moved by muſcles; that they poſſeſs the ſame ſenſes, acknowledge the ſame appetites, and are nouriſhed by the ſame aliment with ourſelves; and we ſhould hence conclude from the ſtrongeſt analogy, that their internal faculties were alſo in ſome meaſure ſimilar to our own.

Mr. Locke indeed publiſhed an opinion, that other animals poſſeſſed no abſtract or general ideas, and thought this circumſtance was the barrier between the brute and the human world. But theſe abſtracted ideas have been ſince demonſtrated by

Biſhop Berkley, and allowed by Mr. Hume, to have no exiſtence in nature, not even in the mind of their inventor, and we are hence neceſſitated to look for ſome other mark of diſtinction.

The ideas and actions of brutes, like thoſe of children, are almoſt perpetually produced by their preſent pleaſures, or their preſent pains; and, except in the few inſtances that have been mentioned in this Section, they ſeldom buſy themſelves about the *means* of procuring future bliſs, or of avoiding future miſery.

Whilſt the acquiring of languages, the making of tools, and the labouring for money; which are all only the *means* of procuring pleaſure: and the praying to the Deity, as another *means* to procure happineſs, are characteriſtic of human nature.

SECT.

SECT. XVII.

THE CATENATION OF MOTIONS.

I. 1. *Catenations of animal motion.* 2. *Are produced by irritations, by ſenſations, by volitions.* 3. *They continue ſome time after they have been excited. Cauſe of catenation.* 4. *We can then exert our attention on other objects.* 5. *Many catenations of motions go on together.* 6. *Some links of the catenations of motions may be left out without diſuniting the chain.* 7. *Interrupted circles of motion continue confuſedly till they come to the part of the circle, where they were diſturbed.* 8. *Weaker catenations are diſſevered by ſtronger.* 9. *Then new catenations take place.* 10. *Much effort prevents their reuniting. Impediment of ſpeech.* 11. *Trains more eaſily diſſevered than circles.* 12. *Sleep deſtroys volition and external ſtimulus.* II. *Inſtances of various catenations in a young lady playing on the harpſichord.* III. 1. *What catenations are the ſtrongeſt.* 2. *Irritations joined with aſſociations from ſtrongeſt connexions. Vital motions.* 3. *New links with increaſed force, cold fits of fever produced.* 4. *New links with decreaſed force. Cold bath.* 5. *Irritation joined with ſenſation. Inflammatory fever. Why children cannot tickle themſelves.* 6. *Volition joined with ſenſation. Irritative ideas of ſound become ſenſible.* 7. *Ideas of imagination diſſevered by irritation, by volition, production of ſurpriſe.*

I. 1. To inveſtigate with preciſion the catenations of animal motions, it would be well to attend to the manner of their production: but we cannot

begin this diſquiſition early enough for this purpoſe, as the catenations of motion ſeem to begin with life, and are only extinguiſhable with it. We have ſpoken of the power of irritation, of ſenſation, of volition, and of aſſociation, as preceding the fibrous motions; we now ſtep forwards, and conſider, that converſely they are in their turn preceded by thoſe motions; and that all the ſucceſſive trains or circles of our actions are compoſed of this twofold concatenation. Thoſe we ſhall call trains of action which continue to proceed without any ſtated repetitions; and thoſe circles of action, when the parts of them return at certain periods, though the trains of which they conſiſt, are not exactly ſimilar. The reading an epic poem is a train of actions; the reading a ſong with a chorus at equal diſtances in the meaſure conſtitutes ſo many circles of action.

2. Some catenations of animal motion are produced by reiterated ſucceſſive irritations, as when we learn to repeat the alphabet in its order by frequently reading the letters of it. Thus the vermicular motions of the bowels were originally produced by the ſucceſſive irritations of the paſſing aliment; and the ſucceſſion of actions of the auricles and ventricles of the heart was originally formed by ſucceſſive ſtimulus of the blood, theſe afterwards become part of the diurnal circles of animal actions, as appears by the periodical returns of hunger, and the quickened pulſe of weak people in the evening.

Other catenations of animal motion are gradually acquired by ſucceſſive agreeable ſenſations, as in learning a favourite ſong or dance; others by diſagreeable ſenſations, as in coughing or nictitation; theſe become aſſociated by frequent repetition, and afterwards compoſe parts of greater circles of action like thoſe above mentioned.

Other

Other catenations of motions are gradually acquired by frequent voluntary repetitions; as when we deliberately learn to march, read, fence, or any mechanic art, the motions of many of our muſcles become gradually linked together in trains, tribes, or circles of action. Thus when any one at firſt begins to uſe the tools in turning wood or metals in a lathe, he wills the motions of his hand or fingers, till at length theſe actions become ſo connected with the effect, that he ſeems only to will the point of the chiſſel. Theſe are cauſed by volition, connected by aſſociation like thoſe above deſcribed, and afterwards become parts of our diurnal trains or circles of action.

3. All theſe catenations of animal motions are liable to proceed ſome time after they are excited, unleſs they are diſturbed or impeded by other irritations, ſenſations, or volitions; and in many inſtances in ſpite of our endeavours to ſtop them; and this property of animal motions is probably the cauſe of their catenation. Thus when a child revolves ſome minutes on one foot, the ſpectra of the ambient objects appear to circulate round him ſome time after he falls upon the ground. Thus the palpitation of the heart continues ſome time after the object of fear, which occaſioned it, is removed. The bluſh of ſhame, which is an exceſs of ſenſation, and the glow of anger, which is an exceſs of volition, continue ſome time, though the affected perſon finds, that thoſe emotions were cauſed by miſtaken facts, and endeavours to extinguiſh their appearance. See Sect. XII. 1. 5.

4. When a circle of motions becomes connected by frequent repetitions as above, we can exert our attention ſtrongly on other objects, and the concatenated circle of motions will nevertheleſs proceed in due order; as whilſt you are thinking on this

ſubjects,

ſubject, you uſe variety of muſcles in walking about your parlour, or ſitting at your writing-table.

5. Innumerable catenations of motions may proceed at the ſame time, without incommoding each other. Of theſe are the motions of the heart and arteries; thoſe of digeſtion and glandular ſecretion; of the ideas, or ſenſual motions; thoſe of progreſſion, and of ſpeaking; the great annual circle of actions ſo apparent in birds in their times of breeding and moulting; the monthly circles of many female animals; and the diurnal circles of ſleeping and waking, of fulneſs and inanition.

6. Some links of ſucceſſive trains or of ſynchronous tribes of action may be left out without disjoining the whole. Such are our uſual trains of recollection; after having travelled through an entertaining country, and viewed many delightful lawns, rolling rivers, and echoing rocks; in the recollection of our journey we leave out the many diſtricts, that we croſſed, which were marked with no peculiar pleaſure. Such alſo are our complex ideas, they are catenated tribes of ideas, which do not perfectly reſemble their correſpondent perceptions, becauſe ſome of the parts are omitted.

7. If an interrupted circle of actions is not entirely diſſevered, it will continue to proceed confuſedly, till it comes to the part of the circle, where it was interrupted.

The vital motions in a fever from drunkenneſs, and in other periodical diſeaſes, are inſtances of this circumſtance. The accidental inebriate does not recover himſelf perfectly till about the ſame hour on the ſucceeding day. The accuſtomed drunkard is diſordered, if he has not his uſual potation of fermented liquor. So if a conſiderable part of a connected tribe of action be diſturbed, that whole tribe goes on with confuſion, till the part of the tribe affected regains its accuſtomed catenations.

tenations. So vertigo produces vomiting, and a great ſecretion of bile, as in ſea-ſickneſs, all theſe being parts of the tribe of irritative catenations.

8. Weaker catenated trains may be diſſevered by the ſudden exertion of the ſtronger. When a child firſt attempts to walk acroſs a room, call to him, and he inſtantly falls upon the ground. So while I am thinking over the virtues of my friends, if the tea-kettle ſpurt out ſome hot water on my ſtocking; the ſudden pain breaks the weaker chain of ideas, and introduces a new group of figures of its own. This circumſtance is extended to ſome unnatural trains of action, which have not been confirmed by long habit; as the hiccough, or an ague-fit, which are frequently curable by ſurpriſe. A young lady about eleven years old had for five days had a contraction of one muſcle in her fore arm, and another in her arm, which occurred four or five times every minute; the muſcles were ſeen to leap, but without bending the arm. To counteract this new morbid habit, an iſſue was placed over the convulſed muſcle of her arm, and an adheſive plaſter wrapped tight like a bandage over the whole fore arm, by which the new motions were immediately deſtroyed, but the means were continued ſome weeks to prevent a return.

9. If any circle of actions is diſſevered, either by omiſſion of ſome of the links, as in ſleep, or by inſertion of other links, as in ſurpriſe, new catenations take place in a greater or leſs degree. The laſt link of the broken chain of actions becomes connected with the new motion which has broken it, or with that which was neareſt the link omitted; and theſe new catenations proceed inſtead of the old ones. Hence the periodic returns of ague-fits, and the chimeras of our dreams.

10. If a train of actions is diſſevered, much effort of volition or ſenſation will prevent its being reſtored.

reſtored. Thus in the common impediment of ſpeech, when the aſſociation of the motions of the muſcles of enunciation with the idea of the word to be ſpoken is diſordered, the great voluntary efforts, which diſtort the countenance, prevent the rejoining of the broken aſſociations. See No. II. 10. of this Section. It is thus likewiſe obſervable in ſome inflammations of the bowels, the too ſtrong efforts made by the muſcles to carry forward the offending material fixes it more firmly in its place, and prevents the cure. So in endeavouring to recal to our memory ſome particular word of a ſentence, if we exert ourſelves too ſtrongly about it, we are leſs likely to regain it.

11. Catenated trains or tribes of action are eaſier diſſevered than catenated circles of action. Hence in epileptic fits the ſynchronous connected tribes of action, which keep the body erect, are diſſevered, but the circle of vital motions continues undiſturbed.

12. Sleep deſtroys the power of volition, and precludes the ſtimuli of external objects, and thence diſſevers the trains, of which theſe are a part; which confirms the other catenations, as thoſe of the vital motions, ſecretions, and abſorptions; and produces the new trains of ideas, which conſtitute our dreams.

II. 1. All the preceding circumſtances of the catenations of animal motions will be more clearly underſtood by the following example of a perſon learning muſic; and when we recollect the variety of mechanic arts, which are performed by aſſociated trains of muſcular actions catenated with the effects they produce, as in knitting, netting, weaving; and the greater variety of aſſociated trains of ideas cauſed or catenated by volitions or ſenſations, as in our

our hourly modes of reaſoning, or imagining. or recollecting, we ſhall gain ſome idea of the innumerable catenated trains and circles of action, which form the tenor of our lives, and which began, and will only ceaſe entirely with them.

2. When a young lady begins to learn muſic, ſhe voluntarily applies herſelf to the characters of her muſic-book, and by many repetitions endeavours to catenate them with the proportions of ſound, of which they are ſymbols. The idea excited by the muſical characters are ſlowly connected with the keys of the harpſichord, and much effort is neceſſary to produce every note with the proper finger, and in its due place and time; till at length a train of voluntary exertions becomes catenated with certain irritations. As the various notes by frequent repetitions become connected in the order, in which they are produced, a new catenation of ſenſitive exertions becomes mixed with the voluntary ones above deſcribed; and not only the muſical ſymbols of crotchets and quavers, but the auditory notes and tones at the ſame time, become ſo many ſucceſſive or ſynchronous links in this circle of catenated actions.

At length the motions of her fingers become catenated with the muſical characters; and theſe no ſooner ſtrike the eye, than the finger preſſes down the key without any voluntary attention between them: the activity of the hand being connected with the irritation of the figure or place of the muſical ſymbol on the retina; till at length by frequent repetitions of the ſame tune the movements of her fingers in playing, and the muſcles of the larynx in ſinging, become aſſociated with each other, and form part of thoſe intricate trains and circles of catenated motions, according with the ſecond article of the preceding propoſitions in No. 1. of this Section.

3. Beſides

3. Beſides the facility, which by habit attends the execution of this muſical performance, a curious circumſtance occurs, which is, that when our young muſician has begun a tune, ſhe finds herſelf inclined to continue it; and that even when ſhe is careleſsly ſinging alone without attending to her own ſong; according with the third preceding article.

4. At the ſame time that our young performer continues to play with great exactneſs this accuſtomed tune, ſhe can bend her mind, and that intenſely, on ſome other object, according with the fourth article of the preceding propoſitions.

The manuſcript copy of this work was lent to many of my friends at different times for the purpoſe of gaining their opinions and criticiſms on many parts of it, and I found the following anecdote written with a pencil opoſite to this page, but am not certain by whom. "I remember ſeeing the pretty young actreſs, who ſucceeded Mrs. Arne in the performance of the celebrated Padlock, rehearſe the muſical parts at her harpſichord under the eye of her maſter with great taſte and accuracy; though I obſerved her countenance full of emotion, which I could not account for; at laſt ſhe ſuddenly burſt into tears; for ſhe had all this time been eyeing a beloved canary bird, ſuffering great agonies, which at that inſtant fell dead from its perch."

5. At the ſame time many other catenated circles of action are going on in the perſon of our fair muſician, as well as the motions of her fingers, ſuch as the vital motions, reſpiration, the movements of her eyes and eyelids, and of the intricate muſcles of vocality, according with the fifth preceding article.

6. If by any ſtrong impreſſion on the mind of our fair muſician ſhe ſhould be interrupted for a very

very inconſiderable time, ſhe can ſtill continue her performance, according to the ſixth article.

7. If however this interruption be greater, though the chain of actions be not diſſevered, it proceeds confuſedly, and our young performer continues indeed to play, but in a hurry without accuracy and elegance, till ſhe begins the tune again, according to the ſeventh of the preceding articles.

8. But if this interruption be ſtill greater, the circle of actions becomes entirely diſſevered, and ſhe finds herſelf immediately under the neceſſity to begin over again to recover the loſt catenation, according to the eighth preceding article.

9. Or in trying to recover it ſhe will ſing ſome diſſonant notes, or ſtrike ſome improper keys, according to the ninth preceding article.

10. A very remarkable thing attends this breach of catenation, if the performer has forgotten ſome word of her ſong, the more energy of mind ſhe uſes about it, the more diſtant is ſhe from regaining it; and artfully employs her mind in part on ſome other object, or endeavours to dull its perceptions, continuing to repeat, as it were inconſciouſly, the former part of the ſong, that ſhe remembers, in hopes to regain the loſt connexion.

For if the activity of the mind itſelf be more energetic, or takes its attention more, than the connecting word, which is wanted; it will not perceive the ſlighter link of this loſt word; as who liſtens to a feeble ſound, muſt be very ſilent and motionleſs; ſo that in this caſe the very vigour of the mind itſelf ſeems to prevent it from regaining the loſt catenation, as well as the too great exertion in endeavouring to regain it, according to the tenth preceding article.

We frequently experience, when we are doubtful about the ſpelling of a word, that the greater voluntary exertion we uſe, that is the more intenſely we think about it, the further are we from regaining the loſt aſſociation between the letters of it, but which readily recurs when we have become careleſs about it. In the ſame manner, after having for an hour laboured to recollect the name of ſome abſent perſon, it ſhall ſeem, particularly after ſleep, to come into the mind as it were ſpontaneouſly; that is, the word we are in ſearch of, was joined to the preceding one by aſſociation; this aſſociation being diſſevered, we endeavour to recover it by volition; this very action of the mind ſtrikes our attention more, than the faint link of aſſociation, and we find it impoſſible by this means to retrieve the loſt word. After ſleep, when volition is entirely ſuſpended, the mind becomes capable of perceiving the fainter link of aſſociation, and the word is regained.

On this circumſtance depends the impediment of ſpeech before mentioned; the firſt ſyllable of a word is cauſable by volition, but the remainder of it is in common converſation introduced by its aſſociations with this firſt ſyllable acquired by long habit. Hence when the mind of the ſtammerer is vehemently employed on ſome idea of ambition of ſhining, or fear of not ſucceeding, the aſſociations of the motions of the muſcles of articulation with each other become diſſevered by this greater exertion, and he endeavours in vain by voluntary efforts to rejoin the broken aſſociation. For this purpoſe he continues to repeat the firſt ſyllable, which is cauſable by volition, and ſtrives in vain, by various diſtortions of countenance, to produce the next links, which are ſubject to aſſociation. See Claſs IV. 3, 1. 1.

11. After our accompliſhed muſician has acquired great variety of tunes and ſongs, ſo that ſome of them

them begin to ceaſe to be eaſily recollected, ſhe finds progreſſive trains of muſical notes more frequently forgotten, than thoſe which are compoſed of reiterated circles, according with the eleventh preceding article.

12. To finiſh our example with the preceding articles we muſt at length ſuppoſe, that our fair performer falls aſleep over her harpſichord; and thus by the ſuſpenſion of volition, and the excluſion of external ſtimuli, ſhe diſſevers the trains and circles of her muſical exertions.

III. 1. Many of theſe circumſtances of catenations of motions receive an eaſy explanation from the four following conſequences to the ſeventh law of animal cauſation in Sect. IV. Theſe are, firſt, that thoſe ſucceſſions or combinations of animal motions, whether they were united by cauſation, aſſociation, or catenation, which have been moſt frequently repeated, acquire the ſtrongeſt connection. Secondly, that of theſe, thoſe, which have been leſs frequently mixed with other trains or tribes of motion, have the ſtrongeſt connection. Thirdly, that of theſe, thoſe, which were firſt formed, have the ſtrongeſt connection. Fourthly, that if an animal motion be excited by more than one cauſation, aſſociation, or catenation, at the ſame time, it will be performed with greater energy.

2. Hence alſo we underſtand, why the catenations of irritative motions are more ſtrongly connected than thoſe of the other claſſes, where the quantity of unmixed repetition has been equal; becauſe they were firſt formed. Such are thoſe of the ſecerning and abſorbent ſyſtems of veſſels, where the action of the gland produces a fluid, which ſtimulates the mouths of its correſpondent abſorbents. The aſſociated motions ſeem to be the next moſt ſtrongly united, from their frequent repetition, and where both theſe circumſtances unite, as in the vital motions

motions, their catenations are indiſſoluble but by the deſtruction of the animal.

3. Where a new link has been introduced into a circle of actions by ſome accidental defect of ſtimulus; if that defect of ſtimulus be repeated at the ſame part of the circle a ſecond or a third time, the defective motions thus produced, both by the repeated defect of ſtimulus and by their catenation with the parts of the circle of actions, will be performed with leſs and leſs energy. Thus if any perſon is expoſed to cold at a certain hour to-day, ſo long as to render ſome part of the ſyſtem for a time torpid; and is again expoſed to it at the ſame hour to-morrow, and the next day; he will be more and more affected by it, till at length a cold fit of fever is completely formed, as happens at the beginning of many of thoſe fevers, which are called nervous or low fevers. Where the patient has ſlight periodical ſhiverings and paleneſs for many days before the febrile paroxyſm is completely formed.

4. On the contrary, if the expoſure to cold be for ſo ſhort a time, as not to induce any conſiderable degree of torpor or quieſcence, and is repeated daily as above mentioned, it loſes its effect more and more at every repetition, till the conſtitution can bear it without inconvenience, or indeed without being conſcious of it. As in walking into the cold air in froſty weather. The ſame rule is applicable to increaſed ſtimulus, as of heat, or of vinous ſpirit, within certain limits, as is applied in the two laſt paragraphs to Deficient Stimulus, as is further explained in Sect. XXXVI. on the Periods of Diſeaſes.

5. Where irritation coincides with ſenſation to produce the ſame catenations of motion, as in inflammatory fevers, they are excited with ſtill greater energy than by the irritation alone. So when children expect to be tickled in play, by a feather lightly paſſed over the lips, or by gently vellicating the ſoles

ſoles of their feet, laughter is moſt vehemently excited; though they can ſtimulate theſe parts with their own fingers unmoved. Here the pleaſurable idea of playfulneſs coincides with the vellication; and there is no voluntary exertion uſed to diminiſh the ſenſation, as there would be, if a child ſhould endeavour to tickle himſelf. See Sect. XXXIV. 1. 4.

6. And laſtly, the motions excited by the junction of voluntary exertion with irritation are performed with more energy, than thoſe by irritation ſingly; as when we liſten to ſmall noiſes, as to the ticking of a watch in the night, we perceive the moſt weak ſounds, that are at other times unheeded. So when we attend to the irritative ideas of ſound in our ears, which are generally not attended to, we can hear them; and can ſee the ſpectra of objects, which remain in the eye, whenever we pleaſe to exert our voluntary power in aid of thoſe weak actions of the retina, or of the auditory nerve.

7. The temporary catenations of ideas, which are cauſed by the ſenſations of pleaſure or pain, are eaſily diſſevered either by irritations, as when a ſudden noiſe diſturbs a day-dream; or by the power of volition, as when we awaken from ſleep. Hence in our waking hours, whenever an idea occurs, which is incongruous to our former experience, we inſtantly diſſever the train of imagination by the power of volition, and compare the incongruous idea with our previous knowledge of nature, and reject it. This operation of the mind has not yet acquired a ſpecific name, though it is exerted every minute of our waking hours; unleſs it may be termed INTUITIVE ANALOGY. It is an act of reaſoning of which we are unconſcious except from its effects in preſerving the congruity of our ideas, and bears the ſame relation to the ſenſorial power of volition, that irritative ideas, of which we are unconſcious except by

by their effects, do to the ſenſorial power of irritation; as the former is produced by volition without our attention to it, and the latter by irritation without our attention to them.

If on the other hand a train of imagination or of voluntary ideas are excited with great energy, and paſſing on with great vivacity, and become diſſevered by ſome violent ſtimulus, as the diſcharge of a piſtol near one's ear, another circumſtance takes place, which is termed SURPRISE; which by exciting violent irritation, and violent ſenſation, employs for a time the whole ſenſorial energy, and thus diſſevers the paſſing trains of ideas, before the power of volition has time to compare them with the uſual phenomena of nature. In this caſe fear is generally the companion of ſurpriſe, and adds to our embarraſſment, as every one experiences in ſome degree when he hears a noiſe in the dark, which he cannot inſtantly account for. This catenation of fear with ſurpriſe is owing to our perpetual experience of injuries from external bodies in motion, unleſs we are upon our guard againſt them. See Sect. XVIII. 17. and XIX. 2.

Many other examples of the catenations of animal motions are explained in Sect. XXXVI. on the Periods of Diſeaſes.

SECT.

SECT. XVIII.

OF SLEEP.

1. *Volition is ſuſpended in ſleep.* 2. *Senſation continues. Dreams prevent delirium and inflammation.* 3. *Nightmare.* 4. *Ceaſeleſs flow of ideas in dreams.* 5. *We ſeem to receive them by the ſenſes. Optic nerve perfectly ſenſible in ſleep. Eyes leſs dazzled after dreaming of viſible objects.* 6. *Reverie, belief.* 7. *How we diſtinguiſh ideas from perceptions.* 8. *Variety of ſcenery in dreams, excellence of the ſenſe of viſion.* 9. *Novelty of combination in dreams.* 10. *Diſtinctneſs of imagery in dreams.* 11. *Rapidity of tranſaction in dreams.* 12. *Of meaſuring time. Of dramatic time and place. Why a dull play induces ſleep, and an intereſting one reverie.* 13. *Conſciouſneſs of our exiſtence and identity in dreams.* 14. *How we awake ſometimes ſuddenly, ſometimes frequently.* 15. *Irritative motions continue in ſleep, internal irritations are ſucceeded by ſenſation. Senſibility increaſes during ſleep, and irritability. Morning dreams. Why epilepſies occur in ſleep. Ecſtacy of children. Caſe of convulſions in ſleep. Cramp, why painful. Aſthma. Morning ſweats. Increaſe of heat. Increaſe of urine in ſleep. Why more liable to take cold in ſleep. Catarrh from thin night-caps. Why we feel chilly at the approach of ſleep, and at waking in the open air.* 16. *Why the gout commences in ſleep. Secretions are more copious in ſleep, young animals and plants grow more in ſleep.* 17. *Inconſiſtency of dreams. Abſence of ſurpriſe in dreams.* 18. *Why we forget ſome dreams and not others.* 19. *Sleep-talkers awake with ſurpriſe.* 20. *Remote*

cauſes of ſleep. Atmoſphere with leſs oxygene. Compreſſion of the brain in ſpina bifida. By whirling on an horizontal wheel. By cold. 21. *Definition of ſleep.*

I. THERE are four ſituations of our ſyſtem, which in their moderate degrees are not uſually termed diſeaſes, and yet abound with many very curious and inſtructive phenomena; theſe are ſleep, reverie, vertigo, drunkenneſs. Theſe we ſhall previouſly conſider, before we ſtep forwards to develop the cauſes and cures of diſeaſes with the modes of the operation of medicines.

As all thoſe trains and tribes of animal motion, which are ſubjected to volition, were the laſt that were cauſed, their connection is weaker than that of the other claſſes; and there is a peculiar circumſtance attending this cauſation, which is, that it is entirely ſuſpended during ſleep; whilſt the other claſſes of motion, which are more immediately neceſſary to life, as thoſe cauſed by internal ſtimuli, for inſtance the pulſations of the heart and arteries, or thoſe catenated with pleaſurable ſenſation, as the powers of digeſtion, continue to ſtrengthen their habits without interruption. Thus though man in his ſleeping ſtate is a much leſs perfect animal than in his waking hours; and though he conſumes more than one third of his life in this his irrational ſituation; yet is the wiſdom of the Author of nature manifeſt even in this ſeeming imperfection of his work!

The truth of this aſſertion with reſpect to the large muſcles of the body, which are concerned in locomotion, is evident; as no one in perfect ſanity walks about in his ſleep, or performs any domeſtic offices; and in reſpect to the mind, we never exerciſe our reaſon or recollection in dreams; we may ſometimes ſeem diſtracted between contending paſſions,

ſions, but we never compare their objects, or deliberate about the acquiſition of thoſe objects, if our ſleep is perfect. And though many ſynchronous tribes or ſucceſſive trains of ideas may repreſent the houſes or walks, which have real exiſtence, yet are they here introduced by their connection with our ſenſations, and are in truth ideas of imagination, not of recollection.

2. For our ſenſations of pleaſure and pain are experienced with great vivacity in our dreams; and hence all that motley group of ideas, which are cauſed by them, called the ideas of imagination, with their various aſſociated trains, are in a very vivid manner acted over in the ſenſorium; and theſe ſometimes call into action the larger muſcles, which have been much aſſociated with them; as appears from the muttering ſentences, which ſome people utter in their dreams, and from the obſcure barking of ſleeping dogs, and the motions of their feet and noſtrils.

This perpetual flow of the trains of ideas, which conſtitute our dreams, and which are cauſed by painful or pleaſurable ſenſation, might at firſt view be conceived to be an uſeleſs expenditure of ſenſorial power. But it has been ſhewn, that thoſe motions, which are perpetually excited, as thoſe of the arterial ſyſtem by the ſtimulus of the blood, are attended by a great accumulation of ſenſorial power, after they have been for a time ſuſpended; as the hot-fit of fever is the conſequence of the cold one. Now as theſe trains of ideas cauſed by ſenſation are perpetually excited during our waking hours, if they were to be ſuſpended in ſleep like the voluntary motions, (which are exerted only by intervals during our waking hours,) an accumulation of ſenſorial power would follow; and on our awaking a delirium would ſupervene, ſince theſe ideas cauſed by ſenſation would be produced with ſuch energy,

that we ſhould miſtake the trains of imagination for ideas excited by irritation; as perpetually happens to people debilitated by fevers on their firſt awaking; for in theſe fevers with debility the general quantity of irritation being diminiſhed, that of ſenſation is increaſed. In like manner if the actions of the ſtomach, inteſtines, and various glands, which are perhaps in part at leaſt cauſed by or catenated with agreeable ſenſation, and which perpetually exiſt during our waking hours, were like the voluntary motions ſuſpended in our ſleep; the great accumulation of ſenſorial power, which would neceſſarily follow, would be liable to excite inflammation in them.

3. When by our continued poſture in ſleep, ſome uneaſy ſenſations are produced, we either gradually awake by the exertion of volition, or the muſcles connected by habit with ſuch ſenſations alter the poſition of the body; but where the ſleep is uncommonly profound, and thoſe uneaſy ſenſations great, the diſeaſe called the incubus, or nightmare, is produced. Here the deſire of moving the body is painfully exerted, by the power of moving it, or volition, is incapable of action, till we awake. Many leſs diſagreeable ſtruggles in our dreams, as when we wiſh in vain to fly from terrifying objects, conſtitute a ſlighter degree of this diſeaſe. In awaking from the nightmare I have more than once obſerved, that there was no diſorder in my pulſe; nor do I believe the reſpiration is laborious, as ſome have affirmed. It occurs to people whoſe ſleep is too profound, and ſome diſagreeable ſenſation exiſts, which at other times would have awakened them, and have thence prevented the diſeaſe of nightmare; as after great fatigue or hunger with too large a ſupper and wine, which occaſion our ſleep to be uncommonly profound. See No. 14, of this Section.

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4. As the larger muſcles of the body are much more frequently excited by volition than by ſenſation, they are but ſeldom brought into action in our ſleep: but the ideas of the mind are by habit much more frequently connected with ſenſation than with volition; and hence the ceaſeleſs flow of our ideas in dreams. Every one's experience will teach him this truth, for we all daily exert much voluntary muſcular motion: but few of mankind can bear the fatigue of much voluntary thinking.

5. A very curious circumſtance attending theſe our ſleeping imaginations is, that we ſeem to receive them by the ſenſes. The muſcles, which are ſubſervient to the external organs of ſenſe, are connected with volition, and ceaſe to act in ſleep; hence the eyelids are cloſed, and the tympanum of the ear relaxed: and it is probable a ſimilarity of voluntary exertion may be neceſſary for the perceptions of the other nerves of ſenſe; for it is obſerved that the papillæ of the tongue can be ſeen to become erected, when we attempt to taſte any thing extremely grateful. Hewſon Exper. Enquir. V. 2. 186. Albini Annot. Acad. L. i. c. 15. Add to this, that the immediate organs of ſenſe have no objects to excite them in the darkneſs and ſilence of the night; but their nerves of ſenſe nevertheleſs continue to poſſeſs their perfect activity ſubſervient to all their numerous ſenſitive connections. This vivacity of our nerves of ſenſe during the time of ſleep is evinced by a circumſtance, which almoſt every one muſt at ſome time or other have experienced; that is, if we ſleep in the day-light, and endeavour to ſee ſome object in our dream, the light is exceedingly painful to our eyes; and after repeated ſtruggles we lament in our ſleep, that we cannot ſee it. In this caſe I apprehend the eye-lid is in ſome degree opened by the vehemence of our ſenſations; and, the iris being dilated, the optic

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nerve ſhews as great or greater ſenſibility than in our waking hours. See No. 15. of this Section.

When we are forcibly waked at midnight from profound ſleep, our eyes are much dazzled with the light of the candle for a minute or two, after there has been ſufficient time allowed for the contraction of the iris; which is owing to the accumulation of ſenſorial power in the organ of viſion during its ſtate of leſs activity. But when we have dreamt much of viſible objects, this accumulation of ſenſorial power in the organ of viſion is leſſened or prevented, and we awake in the morning without being dazzled with the light, after the iris has had time to contract itſelf. This is a matter of great curioſity, and may be thus tried by any one in the day-light. Cloſe your eyes, and cover them with your hat; think for a minute on a tune, which you are accuſtomed to, and endeavour to ſing it with as little activity of mind as poſſible. Suddenly uncover and open your eyes, and in one ſecond of time the iris will contract itſelf, but you will perceive the day more luminous for ſeveral ſeconds, owing to the accumulation of ſenſorial power in the optic nerve.

Then again cloſe and cover your eyes, and think intenſely on a cube of ivory two inches diameter, attending firſt to the north and ſouth ſides of it, and then to the other four ſides of it; then get a clear image in your mind's eye of all the ſides of the ſame cube coloured red; and then of it coloured green; and then of it coloured blue; laſtly, open your eyes as in the former experiment, and after the firſt ſecond of time allowed for the contraction of the iris, you will not perceive any increaſe of the light of the day, or dazzling; becauſe now there is no accumulation of ſenſorial power in the optic nerve; that having been expended by its action in thinking over viſible objects.

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This experiment is not eaſy to be made at firſt, but by a few patient trials the fact appears very certain; and ſhews clearly, that our ideas of imagination are repetitions of the motions of the nerve, which were originally occaſioned by the ſtimulus of external bodies; becauſe they equally expend the ſenſorial power in the organ of ſenſe. See Sect. III. 4. which is analogous to our being as much fatigued by thinking as by labour.

6. Nor is it in our dreams alone, but even in our waking reveries, and in great efforts of invention, ſo great is the vivacity of our ideas, that we do not for a time diſtinguiſh them from the real preſence of ſubſtantial objects; though the external organs of ſenſe are open, and ſurrounded with their uſual ſtimuli. Thus whilſt I am thinking over the beautiful valley, through which I yeſterday travelled, I do not perceive the furniture of my room: and there are ſome, whoſe waking imaginations are ſo apt to run into perfect reverie, that in their common attention to a favourite idea they do not hear the voice of the companion, who accoſts them, unleſs it is repeated with unuſual energy.

This perpetual miſtake in dreams and reveries, where our ideas of imagination are attended with a belief of the preſence of external objects, evinces beyond a doubt, that all our ideas are repetitions of the motions of the nerves of ſenſe, by which they were acquired; and that this belief is not, as ſome late philoſophers contend, an inſtinct neceſſarily connected only with our perceptions.

7. A curious queſtion demands our attention in this place; as we do not diſtinguiſh in our dreams and reveries between our perceptions of external objects, and our ideas of them in their abſence, how do we diſtinguiſh them at any time? In a dream, if the ſweetneſs of ſugar occurs to my imagination, the whiteneſs and hardneſs of it, which were

were ideas uſually connected with the ſweetneſs, immediately follow in the train; and I believe a material lump of ſugar preſent before my ſenſes: but in my waking hours, if the ſweetneſs occurs to my imagination, the ſtimulus of the table to my hand, or of the window to my eye, prevents the other ideas of the hardneſs and whiteneſs of the ſugar from ſucceeding; and hence I perceive the fallacy, and diſbelieve the exiſtence of objects correſpondent to thoſe ideas, whoſe tribes or trains are broken by the ſtimulus of other objects. And further in our waking hours, we frequently exert our volition in comparing preſent appearances with ſuch, as we have uſually obſerved; and thus correct the errors of one ſenſe by our general knowledge of nature by intuitive analogy. See Sect. XVII. 3. 7. Whereas in dreams the power of volition is ſuſpended, we can recollect and compare our preſent ideas with none of our acquired knowledge, and are hence incapable of obſerving any abſurdities in them.

By this criterion we diſtinguiſh our waking from our ſleeping hours, we can voluntarily recollect our ſleeping ideas, when we are awake, and compare them with our waking ones; but we cannot in our ſleep *voluntarily* recollect our waking ideas at all.

8. The vaſt variety of ſcenery, novelty of combination, and diſtinctneſs of imagery, are other curious circumſtances of our ſleeping imaginations. The variety of ſcenery ſeems to ariſe from the ſuperior activity and excellence of our ſenſe of viſion; which in an inſtant unfolds to the mind extenſive fields of pleaſurable ideas; while the other ſenſes collect their objects ſlowly, and with little combination; add to this, that the ideas, which this organ preſents us with, are more frequently connected with our ſenſation than thoſe of any other.

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9. The great novelty of combination is owing to another circumſtance; the trains of ideas, which are carried on in our waking thoughts, are in our dreams diſſevered in a thouſand places by the ſuſpenſion of volition, and the abſence of irritative ideas, and are hence perpetually falling into new catenations. As explained in Sect. XVI. 1. 9. For the power of volition is perpetually exerted during our waking hours in comparing our paſſing trains of ideas with our acquired knowledge of nature, and thus forms many intermediate links in their catenation. And the irritative ideas excited by the ſtimulus of the objects, with which we are ſurrounded, are every moment intruded upon us, and form other links of our unceaſing catenations of ideas.

10. The abſence of the ſtimuli of external bodies, and of volition, in our dreams renders the organs of ſenſe liable to be more ſtrongly affected by the powers of ſenſation, and of aſſociation. For our deſires or averſions, or the obtruſions of ſurrounding bodies, diſſever the ſenſitive and aſſociate tribes of ideas in our waking hours by introducing thoſe of irritation and volition amongſt them. Hence proceeds the ſuperior diſtinctneſs of pleaſurable or painful imagery in our ſleep; for we recal the figure and the features of a long loſt friend, whom we loved, in our dreams with much more accuracy and vivacity than in our waking thoughts. This circumſtance contributes to prove, that our ideas of imagination are reiterations of thoſe motions of our organs of ſenſe, which were excited by external objects; becauſe while we are expoſed to the ſtimuli of preſent objects, our ideas of abſent objects cannot be ſo diſtinctly formed.

11. The rapidity of the ſucceſſion of tranſactions in our dreams is almoſt inconceivable; inſomuch that, when we are accidentally awakened by the jarring

jarring of a door, which is opened into our bed-chamber, we ſometimes dream a whole hiſtory of thieves or fire in the very inſtant of awaking.

During the ſuſpenſion of volition we cannot compare our other ideas with thoſe of the parts of time in which they exiſt; that is, we cannot compare the imaginary ſcene, which is before us, with thoſe changes of it, which precede or follow it: becauſe this act of comparing requires recollection or voluntary exertion. Whereas in our waking hours, we are perpetually making this compariſon, and by that means our waking ideas are kept conſiſtent with each other by intuitive analogy; but this compariſon retards the ſucceſſion of them, by occaſioning their repetition. Add to this, that the tranſactions of our dreams conſiſt chiefly of viſible ideas, and that a whole hiſtory of thieves and fire may be *beheld* in an inſtant of time like the figures in a picture.

12. From this incapacity of attending to the parts of time in our dreams, ariſes our ignorance of the length of the night; which, but from our conſtant experience to the contrary, we ſhould conclude was but a few minutes, when our ſleep is perfect. The ſame happens in our reveries; thus when we are poſſeſſed with vehement joy, grief, or anger, time appears ſhort, for we exert no volition to compare the preſent ſcenery with the paſt or future; but when we are compelled to perform thoſe exerciſes of mind or body, which are unmixed with paſſion, as in travelling over a dreary country, time appears long; for our deſire to finiſh our journey occaſions us more frequently to compare our preſent ſituation with the parts of time or place, which are before and behind us.

So when we are enveloped in deep contemplation of any kind, or in reverie, as in reading a very intereſting play or romance, we meaſure time very inaccurately; and hence, if a play greatly affects our

our paſſions, the abſurdities of paſſing over many days or years, and of perpetual changes of place, are not perceived by the audience; as is experienced by every one, who reads or ſees ſome plays of the immortal Shakeſpear; but it is neceſſary for inferior authors to obſerve thoſe rules of the πιθανον and πρεπον inculcated by Ariſtotle, becauſe their works do not intereſt the paſſions ſufficiently to produce complete reverie.

Thoſe works, however, whether a romance or a ſermon, which do not intereſt us ſo much as to induce reverie, may nevertheleſs incline us to ſleep. For thoſe pleaſurable ideas, which are preſented to us, and are too gentle to excite laughter, (which is attended with interrupted voluntary exertions, as explained Sect. XXXIV. 1. 4.) and which are not accompanied with any other emotion, which uſually excites ſome voluntary exertion, as anger, or fear, are liable to produce ſleep; which conſiſts in a ſuſpenſion of all voluntary power. But if the ideas thus preſented to us, and intereſt our attention, are accompanied with ſo much pleaſurable or painful ſenſation as to excite our voluntary exertion at the ſame time, reverie is the conſequence. Hence an intereſting play produces reverie, a tedious one produces ſleep: in the latter we become exhauſted by attention, and are not excited to any voluntary exertion, and therefore ſleep; in the former we are excited by ſome emotion, which prevents by its pain the ſuſpenſion of volition, and in as much as it intereſts us, induces reverie, as explained in the next Section.

But when our ſleep is imperfect, as when we have determined to riſe in half an hour, time appears longer to us than in moſt other ſituations. Here our ſolicitude not to overſleep the determined time induces us in this imperfect ſleep to compare the quick changes of imagined ſcenery with the parts of

of time or place, they would have taken up, had they real exiſtence; and that more frequently than in our waking hours; and hence the time appears longer to us: and I make no doubt, but the permitted time appears long to a man going to the gallows, as the fear of its quick lapſe will make him think frequently about it.

13. As we gain our knowledge of time by comparing the preſent ſcenery with the paſt and future, and of place by comparing the ſituations of objects with each other; ſo we gain our idea of conſciouſneſs by comparing ourſelves with the ſcenery around us; and of identity by comparing our preſent conſciouſneſs with our paſt conſciouſneſs: as we never think of time or place, but when we make the compariſons above mentioned, ſo we never think of conſciouſneſs, but when we compare our own exiſtence with that of other objects; nor of identity, but when we compare our preſent and our paſt conſciouſneſs. Hence the conſciouſneſs of our own exiſtence, and of our identity, is owing to a voluntary exertion of our minds: and on that account in our complete dreams we neither meaſure time, are ſurpriſed at the ſudden changes of place, nor attend to our own exiſtence, or identity; becauſe our power of volition is ſuſpended. But all theſe circumſtances are more or leſs obſervable in our incomplete ones; for then we attend a little to the lapſe of time, and the changes of place, and to our own exiſtence; and even to our identity of perſon; for a lady ſeldom dreams, that ſhe is a ſoldier; nor a man, that he is brought to bed.

14. As long as our ſenſations only excite their ſenſual motions, or ideas, our ſleep continues ſound; but as ſoon as they excite deſires or averſions, our ſleep becomes imperfect; and when that deſire or averſion is ſo ſtrong, as to produce voluntary motions,

tions, we begin to awake; the larger muſcles of the body are brought into action to remove that irritation or ſenſation, which a continued poſture has cauſed; we ſtretch our limbs, and yawn, and our ſleep is thus broken by the accumulation of voluntary power.

Sometimes it happens, that the act of waking is ſuddenly produced, and this ſoon after the commencement of ſleep; which is occaſioned by ſome ſenſation ſo diſagreeable, as inſtantaneouſly to excite the power of volition; and a temporary action of all the voluntary motions ſuddenly ſucceeds, and we ſtart awake. This is ſometimes accompanied with loud noiſe in the ears, and with ſome degree of fear; and when it is in great exceſs, ſo as to produce continued convulſive motions of thoſe muſcles, which are generally ſubſervient to volition, it becomes epilepſy: the fits of which in ſome patients generally commence during ſleep. This differs from the night-mare deſcribed in No. 3. of this Section, becauſe in that the diſagreeable ſenſation is not ſo great as to excite the power of volition into action; for as ſoon as that happens, the diſeaſe ceaſes.

Another circumſtance, which ſometimes awakes people ſoon after the commencement of their ſleep, is where the voluntary power is already ſo great in quantity as almoſt to prevent them from falling aſleep, and then a little accumulation of it ſoon again awakens them; this happens in caſes of inſanity, or where the mind has been lately much agitated by fear or anger. There is another circumſtance in which ſleep is likewiſe of ſhort duration, which ariſes from great debility, as after great over-fatigue, and in ſome fevers, where the ſtrength of the patient is greatly diminiſhed, as in theſe caſes the pulſe intermits or flutters, and the reſpiration is previouſly affected, it ſeems to originate from the want

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of ſome voluntary efforts to facilitate reſpiration, as when we are awake. And is further treated of in Vol. II. Claſs I. 2. 1. 2. on the Diſeaſes of the Voluntary Power. Art. Somnus interruptus.

15. We come now to thoſe motions which depend on irritation. The motions of the arterial and glandular ſyſtems continue in our ſleep, proceeding ſlower indeed, but ſtronger and more uniformly, than in our waking hours, when they are incommoded by external ſtimuli, or by the movements of volition; the motions of the muſcles ſubſervient to reſpiration continue to be ſtimulated into action, and the other internal ſenſes of hunger, thirſt, and luſt, are not only occaſionally excited in our ſleep, but their irritative motions are ſucceeded by their uſual ſenſations, and make a part of the farrago of our dreams. Theſe ſenſations of the want of air, of hunger, thirſt, and luſt, in our dreams, contribute to prove, that theſe nerves of the external ſenſes are alſo alive and excitable in our ſleep; but as the ſtimuli of external objects are either excluded from them by the darkneſs and ſilence of the night, or their acceſs to them is prevented by the ſuſpenſion of volition, theſe nerves of ſenſe fall more readily into their connexions with ſenſation and with aſſociation; becauſe much ſenſorial power, which during the day was expended in moving the external organs of ſenſe in conſequence of irritation from external ſtimuli, or in conſequence of volition, becomes now in ſome degree accumulated, and renders the internal or immediate organs of ſenſe more eaſily excitable by the other ſenſorial powers. Thus in reſpect to the eye, the irritation from external ſtimuli, and the power of volition during our waking hours, elevate the eye-lids, adapt the aperture of the iris to the quantity of light, the focus of the cryſtalline humour, and the angle of the optic axiſes to the diſtance of the object, all which perpetual activity

tivity during the day expends much ſenſorial power, which is ſaved during our ſleep.

Hence it appears, that not only thoſe parts of the ſyſtem, which are always excited by internal ſtimuli, as the ſtomach, inteſtinal canal, bile-ducts, and the various glands, but the organs of ſenſe alſo, may be more violently excited into action by the irritation from internal ſtimuli, or by ſenſation, during our ſleep than in our waking hours; becauſe during the ſuſpenſion of volition, there is a greater quantity of the ſpirit of animation to be expended by the other ſenſorial powers. On this account our irritability to internal ſtimuli, and our ſenſibility to pain or pleaſure, is not only greater in ſleep, but increaſes as our ſleep is prolonged. Whence digeſtion and ſecretion are performed better in ſleep, than in our waking hours, and our dreams in the morning have greater variety and vivacity, as our ſenſibility increaſes, than at night when we firſt lie down. And hence epileptic fits, which are always occaſioned by ſome diſagreeable ſenſation, ſo frequently attack thoſe who are ſubject to them, in their ſleep; becauſe at this time the ſyſtem is more excitable by painful ſenſation in conſequence of internal ſtimuli; and the power of volition is then ſuddenly exerted to relieve this pain, as explained Sect XXXIV. 1. 4.

There is a diſeaſe, which frequently affects children in the cradle, which is termed ecſtaſy, and ſeems to conſiſt in certain exertions to relieve painful ſenſation, in which the voluntary power is not ſo far excited as totally to awaken them, and yet is ſufficient to remove the diſagreeable ſenſation, which excites it; in this caſe changing the poſture of the child frequently relieves it.

I have at this time under my care an elegant young man about twenty-two years of age, who ſeldom ſleeps more than an hour without experiencing a convulſion fit; which ceaſes in about half a minute

nute without any ſubſequent ſtupor. Large doſes of opium only prevented the paroxyſms, ſo long as they prevented him from ſleeping by the intoxication, which they induced. Other medicines had no effect on him. He was gently awakened every half hour for one night, but without good effect, as he ſoon ſlept again, and the fit returned at about the ſame periods of time, for the accumulated ſenſorial power, which occaſioned the increaſed ſenſibility to pain, was not thus exhauſted. This caſe evinces, that the ſenſibility of the ſyſtem to internal excitation increaſes, as our ſleep is prolonged; till the pain thus occaſioned produces voluntary exertion; which, when it is in its uſual degree, only awakens us; but when it is more violent, it occaſions convulſions.

The cramp in the calf of the leg is another kind of convulſion, which generally commences in ſleep, occaſioned by the continual increaſe of irritability from internal ſtimuli, or of ſenſibility, during that ſtate of our exiſtence. The cramp is a violent exertion to relieve pain, generally either of the ſkin from cold, or of the bowels, as in ſome diarrhœas, or from the muſcles having been previouſly overſtretched, as in walking up or down ſteep hills. But in theſe convulſions of the muſcles, which form the calf of the leg, the contraction is ſo violent as to occaſion another pain in conſequence of their own too violent contraction, as ſoon as the original pain, which cauſed the contraction, is removed. And hence the cramp, or ſpaſm, of theſe muſcles is continued without intermiſſion by this new pain, unlike the alternate convulſions and remiſſions in epileptic fits. The reaſon, that the contraction of theſe muſcles of the calf of the leg is more violent during their convulſion than that of others, depends on the weakneſs of their antagoniſt muſcles; for after theſe have been contracted in their uſual action, as at every ſtep in walking, they are again extended, not, as moſt other

other muſcles are, by their antagoniſts, but by the weight of the whole body on the balls of the toes; and that weight applied to great mechanical advantage on the heel, that is, on the other end of the bone of the foot, which thus acts as a lever.

Another diſeaſe, the periods of which generally commence during our ſleep, is the aſthma. Whatever may be the remote cauſe of paroxyſms of aſthma, the immediate cauſe of the convulſive reſpiration, whether in the common aſthma, or in what is termed the convulſive aſthma, which are perhaps only different degrees of the ſame diſeaſe, muſt be owing to violent voluntary exertions to relieve pain, as in other convulſions; and the increaſe of irritability to internal ſtimuli, or of ſenſibility, during ſleep muſt occaſion them to commence at this time.

Debilitated people, who have been unfortunately accuſtomed to great ingurgitation of ſpirituous potation, frequently part with a great quantity of water during the night, but with not more than uſual in the day-time. This is owing to a beginning torpor of the abſorbent ſyſtem, and precedes anaſarca, which commences in the day, but is cured in the night by the increaſe of the irritability of the abſorbent ſyſtem during ſleep, which thus imbibes from the cellular membrane the fluids, which had been accumulated there during the day; though it is poſſible the horizontal poſition of the body may contribute ſomething to this purpoſe, and alſo the greater irritability of ſome branches of the abſorbent veſſels, which open their mouths in the cells of the cellular membrane, than that of other branches.

As ſoon as a perſon begins to ſleep, the irritability and ſenſibility of the ſyſtem begins to increaſe, owing to the ſuſpenſion of volition and the excluſion of external ſtimuli. Hence the actions of the veſſels in obedience to internal ſtimulation become ſtronger and more energetic, though leſs frequent in reſpect to number. And as many of the ſecretions are in-

creaſed, ſo the heat of the ſyſtem is gradually increaſed, and the extremities of feeble people, which had been cold during the day, become warm. Till towards morning many people become ſo warm, as to find it neceſſary to throw off ſome of their bedclothes, as ſoon as they awake; and in others ſweats are ſo liable to occur towards morning during their ſleep.

Thus thoſe, who are not accuſtomed to ſleep in the open air, are very liable to take cold, if they happen to fall aſleep on a garden bench, or in a carriage with the window open. For as the ſyſtem is warmer during ſleep, as above explained, if a current of cold air affects any part of the body, a torpor of that part is more effectually produced, as when a cold blaſt of air through a key-hole or caſement falls upon a perſon in a warm room. In thoſe caſes the affected part poſſeſſes leſs irritability in reſpect to heat, from its having previouſly been expoſed to a greater ſtimulus of heat, as in the warm room, or during ſleep; and hence, when the ſtimulus of heat is diminiſhed, a torpor is liable to enſue; that is, we take cold. Hence people who ſleep in the open air, generally feel chilly both at the approach of ſleep, and on their awaking; and hence many people are perpetually ſubject to catarrhs if they ſleep in a leſs warm head-dreſs, than that which they wear in the day.

16. Not only the ſenſorial powers of irritation and of ſenſation, but that of aſſociation alſo appear to act with greater vigour during the ſuſpenſion of volition in ſleep. It will be ſhewn in another place, that the gout generally attacks the liver, and that afterwards an inflammation of the ball of the great toe commences by aſſociation, and that of the liver ceaſes. Now as this change or metaſtaſis of the activity of the ſyſtem generally commences in ſleep, it follows, that theſe aſſociations of motion exiſt with

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greater energy at that time; that is, that the ſenſorial faculty of aſſociation, like thoſe of irritation and of ſenſation, becomes in ſome meaſure accumulated during the ſuſpenſion of volition.

Other aſſociate tribes and trains of motions, as well as the irritative and ſenſitive ones, appear to be increaſed in their activity during the ſuſpenſion of volition in ſleep. As thoſe which contribute to circulate the blood, and to perform the various ſecretions; as well as the aſſociate tribes and trains of ideas, which contribute to furniſh the perpetual ſtreams of our dreaming imaginations.

In ſleep the ſecretions have generally been ſuppoſed to be diminiſhed, as the expectorated mucus in coughs, the fluids diſcharged in diarrhœas, and in ſalivation, except indeed the ſecretion of ſweat, which is often viſibly increaſed. This error ſeems to have ariſen from attention to the excretions rather than to the ſecretions. For the ſecretions, except that of ſweat, are generally received into reſervoirs, as the urine into the bladder, and the mucus of the inteſtines and lungs into their reſpective cavities; but theſe reſervoirs do not exclude theſe fluids immediately by their ſtimulus, but require at the ſame time ſome voluntary efforts, and therefore permit them to remain during ſleep. And as they thus continue longer in thoſe receptacles in our ſleeping hours, a greater part is abſorbed from them, and the remainder becomes thicker, and ſometimes in leſs quantity, though at the time it was ſecreted the fluid was in greater quantity than in our waking hours. Thus the urine is higher coloured after long ſleep; which ſhews, that a greater quantity has been ſecreted, and that more of the aqueous and ſaline part has been reabſorbed, and the earthy part left in the bladder; hence thick urine in fevers ſhews only a greater action of the veſſels which ſecrete it in the kidneys, and of thoſe which abſorb it from the bladder.

The ſame happens to the mucus expectorated in coughs, which is thus thickened by abſorption of its aqueous and ſaline parts; and the ſame of the feces of the inteſtines. From hence it appears, and from what has been ſaid in No. 15, of this Section concerning the increaſe of irritability and of ſenſibility during ſleep, that the ſecretions are in general rather increaſed than diminiſhed during theſe hours of our exiſtence; and it is probable that nutrition is almoſt entirely performed in ſleep; and that young animals grow more at this time than in their waking hours, as young plants have long ſince been obſerved to grow more in the night, which is their time of ſleep.

17. Two other remarkable circumſtances of our dreaming ideas are their inconſiſtency, and the total abſence of ſurpriſe. Thus we ſeem to be preſent at more extraordinary metamorphoſes of animals or trees, than are to be met with in the fables of antiquity; and appear to be tranſported from place, which ſeas divide, as quickly as the changes of ſcenery are performed in a play-houſe; and yet are not ſenſible of their inconſiſtency, nor in the leaſt degree affected with ſurpriſe.

We muſt conſider this circumſtance more minutely. In our waking trains of ideas, thoſe that are inconſiſtent with the uſual order of nature, ſo rarely have occurred to us, that their connexion is the ſlighteſt of all others: hence, when a conſiſtent train of ideas is exhauſted, we attend to the external ſtimuli, that uſually ſurround us, rather than to any inconſiſtent idea which might otherwiſe preſent itſelf; and if an inconſiſtent idea ſhould intrude itſelf, we immediately compare it with the preceding one, and voluntarily reject the train it would introduce; this appears further in the Section on Reverie, in which ſtate of the mind external ſtimuli are not attended to, and yet the ſtreams of ideas are kept conſiſtent by the efforts of volition. But as our faculty of volition

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is ſuſpended, and all external ſtimuli are excluded in ſleep, this ſlighter connexion of ideas take place; and the train is ſaid to be inconſiſtent; that is, diſſimilar to the uſual order of nature.

But, when any conſiſtent train of ſenſitive or voluntary ideas is flowing along, if any external ſtimulus affects us ſo violently, as to intrude irritative ideas forcibly into the mind, it diſunites the former train of ideas, and we are affected with ſurpriſe. Theſe ſtimuli of unuſual energy or novelty not only diſunite our common trains of ideas, but the trains of muſcular motions alſo, which have not been long eſtabliſhed by habit, and diſturb thoſe that have. Some people become motionleſs by great ſurpriſe, the fits of hiccup and of ague have been often removed by it, and it even affects the movements of the heart and arteries; but in our ſleep, all external ſtimuli are excluded, and in conſequence no ſurpriſe can exiſt. See Section XVII. 3. 7.

18. We frequently awake with pleaſure from a dream, which has delighted us, without being able to recollect the tranſactions of it: unleſs perhaps at a diſtance of time, ſome analogous idea may introduce afreſh this forgotten train: and in our waking reveries we ſometimes in a moment loſe the train of thought, but continue to feel the glow of pleaſure, or the depreſſion of ſpirits, it occaſioned: whilſt at other time we can retrace with eaſe theſe hiſtories of our reveries and dreams.

The above explanation of ſurpriſe throws light upon this ſubject. When we are ſuddenly awaked by any violent ſtimulus, the ſurpriſe totally diſunites the trains of our ſleeping ideas from theſe of our waking ones; but if we gradually awake, this does not happen; and we readily unravel the preceding trains of imagination.

19. There are various degrees of ſurpriſe; the more intent we are upon the train of ideas, which we

we are employed about, the more violent muſt be the ſtimulus that interrupts them, and the greater is the degree of ſurpriſe. I have obſerved dogs, who have ſlept by the fire, and by their obſcure barking and ſtruggling have appeared very intent on their prey, that ſhewed great ſurpriſe for a few ſeconds after their awaking by looking eagerly about them; which they did not do at other times of waking. And an intelligent friend of mine has remarked, that his lady, who frequently ſpeaks much and articulately in her ſleep, could never recollect her dreams in the morning, when this happened to her: but that when ſhe did not ſpeak in her ſleep, ſhe could always recollect them.

Hence, when our ſenſations act ſo ſtrongly in ſleep as to influence the larger muſcles, as in thoſe, who talk or ſtruggle in their dreams; or in thoſe, who are affected with complete reverie (as deſcribed in the next Section), great ſurpriſe is produced, when they awake; and theſe, as well as thoſe who are completely drunk or delirious, totally forget afterwards their imaginations at thoſe times.

20. As the immediate cauſe of ſleep conſiſts in the ſuſpenſion of volition, it follows, that whatever diminiſhes the general quantity of ſenſorial power, or derives it from the faculty of volition, will conſtitute a remote cauſe of ſleep; ſuch as fatigue from muſcular or mental exertion, which diminiſhes the general quantity of ſenſorial power; or an increaſe of the ſenſitive motions, as by attending to ſoft muſic, which diverts the ſenſorial power from the faculty of volition; or laſtly, by increaſe of the irritative motions, as by wine, or food, or warmth; which not only by their expenditure of ſenſorial power diminiſh the quantity of volition; but alſo by their producing pleaſurable ſenſations (which occaſion other muſcular or ſenſual motions in conſequence), doubly decreaſe the voluntary power, and thus more forcibly produce ſleep. See Sect. XXXIV. 1. 4.

Another

Another method of inducing ſleep is delivered in a very ingenious work lately publiſhed by Dr. Beddoes. Who, after lamenting that opium frequently occaſions reſtleſſneſs, thinks, "that in moſt caſes it would be better to induce ſleep by the abſtraction of ſtimuli, than by exhauſting the excitability;" and adds, "upon this principle we could not have a better ſoporific than an atmoſphere with a diminiſhed proportion of oxygene air, and that common air might be admitted after the patient was aſleep." (Obſerv. on Calculus, &c. by Dr. Beddoes. Murray.) If it ſhould be found to be true, that the excitability of the ſyſtem depends on the quantity of oxygene abſorbed by the lungs in reſpiration according to the the theory of Dr. Beddoes, and of Mr. Girtanner, this idea of ſleeping in an atmoſphere with leſs oxygene in its compoſition might be of great ſervice in epileptic caſes, and in cramp, and even in fits of the aſthma, where their periods commence from the increaſe of irritability during ſleep.

Sleep is likewiſe ſaid to be induced by mechanic preſſure on the brain in the caſes of ſpina bifida. Where there has been a defect of one of the vertebræ of the back, a tumor is protruded in conſequence; and, whenever this tumor has been compreſſed by the hand, ſleep is ſaid to be induced, becauſe the whole of the brain both within the head and ſpine becomes compreſſed by the retroceſſion of the fluid within the tumor. But by what means a compreſſion of the brain induces ſleep has not been explained, but probably by diminiſhing the ſecretion of ſenſorial power, and then the voluntary motions become ſuſpended previouſly to the irritative ones, as occurs in moſt dying perſons.

Another way of procuring ſleep mechanically was related to me by Mr. Brindley, the famous canal engineer, who was brought up to the buſineſs of a millwright; he told me, that he had more than once

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ſeen the experiment of a man extending himſelf acroſs the large ſtone of a corn-mill, and that by gradually letting the ſtone whirl, the man fell aſleep before the ſtone had gained its full velocity, and he ſuppoſed would have died without pain by the continuance or increaſe of the motion. In this caſe the centrifugal motion of the head and feet muſt accumulate the blood in both thoſe extremities of the body, and thus compreſs the brain.

Laſtly, we ſhould mention the application of cold; which, when in a leſs degree, produces watchfulneſs by the pain it occaſions, and the tremulous convulſions of the ſubcutaneous muſcles; but when it is applied in great degree, is ſaid to produce ſleep. To explain this effect it has been ſaid, that as the veſſels of the ſkin and extremities become firſt torpid by the want of the ſtimulus of heat, and as thence leſs blood is circulated through them, as appears from their paleneſs, a greater quantity of blood poured upon the brain produces ſleep by its compreſſion of that organ. But I ſhould rather imagine, that the ſenſorial power becomes exhauſted by the convulſive actions in conſequence of the pain of cold, and of the voluntary exerciſe previouſly uſed to prevent it, and that the ſleep is only the beginning to die, as the ſuſpenſion of voluntary power in lingering deaths precedes for many hours the extinction of the irritative motions.

21. The following are the characteriſtic circumſtances attending perfect ſleep.

1. The power of volition is totally ſuſpended.

2. The trains of ideas cauſed by ſenſation proceed with greater facility and vivacity; but become inconſiſtent with the uſual order of nature. The muſcular motions cauſed by ſenſation continue; as thoſe concerned in our evacuations during infancy, and afterwards in digeſtion, and in priapiſmus.

3. The

3. The irritative muſcular motions continue, as thoſe concerned in the circulation, in ſecretion, in reſpiration. But the irritative ſenſual motions, or ideas, are not excited; as the immediate organs of ſenſe are not ſtimulated into action by external objects, which are excluded by the external organs of ſenſe; which are not in ſleep adapted to their reception by the power of volition, as in our waking hours.

4. The aſſociate motions continue; but their firſt link is not excited into action by volition, or by external ſtimuli. In all reſpects, except thoſe above mentioned, the three laſt ſenſorial powers are ſomewhat increaſed in energy during the ſuſpenſion of volition, owing to the conſequent accumulation of the ſpirit of animation.

SECT.

SECT. XIX.

OF REVERIE.

1. *Various degrees of reverie.* 2. *Sleep-walkers. Case of a young lady. Great surprise at awaking. And total forgetfulness of what passed in reverie.* 3. *No suspension of volition in reverie.* 4. *Sensitive motions continue, and are consistent.* 5. *Irritative motions continue, but are not succeeded by sensation.* 6. *Volition necessary for the perception of feeble impressions.* 7. *Associated motions continue.* 8. *Nerves of sense are irritable in sleep, but not in reverie.* 9. *Somnambuli are not asleep. Contagion received but once.* 10. *Definition of reverie.*

1. WHEN we are employed with great sensation of pleasure, or with great efforts of volition, in the pursuit of some interesting train of ideas, we cease to be conscious of our existence, are inattentive to time and place, and do not distinguish this train of sensitive and voluntary ideas from the irritative ones excited by the presence of external objects, though our organs of sense are surrounded with their accustomed stimuli, till at length this interesting train of ideas becomes exhausted, or the appulses of external objects are applied with unusual violence, and we return with surprise, or with regret, into the common track of life. This is termed reverie or studium.

In some constitutions these reveries continue a considerable time, and are not to be removed without greater difficulty, but are experienced in a less degree by us all; when we attend earnestly to the ideas excited by volition or sensation, with their associated connexions, but are at the same time

time conſcious at intervals of the ſtimuli of ſurrounding bodies. Thus in being preſent at a play, or in reading a romance, ſome perſons are ſo totally abſorbed as to forget their uſual time of ſleep, and to neglect their meals; while others are ſaid to have been ſo involved in voluntary ſtudy as not to have heard the diſcharge of artillery; and there is a ſtory of an Italian politician, who could think ſo intenſely on other ſubjects, as to be inſenſible to the torture of the rack.

From hence it appears, that theſe catenations of ideas and muſcular motions, which form the trains of reverie, are compoſed both of voluntary and ſenſitive aſſociations of them; and that theſe ideas differ from thoſe of delirium or of ſleep, as they are kept conſiſtent by the power of volition; and they differ alſo from the trains of ideas belonging to inſanity, as they are as frequently excited by ſenſation as by volition. But laſtly, that the whole ſenſorial power is ſo employed on theſe trains of complete reverie, that like the violent efforts of volition, as in convulſions or inſanity; or like the great activity of the irritative motions in drunkenneſs; or of the ſenſitive motions in delirium; they preclude all ſenſation conſequent to external ſtimulus.

2. Thoſe perſons, who are ſaid to walk in their ſleep, are affected with reverie to ſo great a degree, that it becomes a formidable diſeaſe; the eſſence of which conſiſts in the inaptitude of the mind to attend to external ſtimuli. Many hiſtories of this diſeaſe have been publiſhed by medical writers; of which there is a very curious one in the Lauſanne Tranſactions. I ſhall here ſubjoin an account of ſuch a caſe, with its cure, for the better illuſtration of this ſubject.

A very ingenious and elegant young lady, with light eyes and hair, about the age of ſeventeen, in other

other reſpects well, was ſuddenly ſeized ſoon after her uſual menſtruation, with this very wonderful malady. The diſeaſe began with vehement convulſions of almoſt every muſcle of her body, with great but vain efforts to vomit, and the moſt violent hiccoughs, that can be conceived: theſe were ſucceeded in about an hour with a fixed ſpaſm; in which one hand was applied to her head, and the other to ſupport it: in about half an hour theſe ceaſed, and the reverie began ſuddenly, and was at firſt manifeſt by the look of her eyes and countenance, which ſeemed to expreſs attention. Then ſhe converſed aloud with imaginary perſons with her eyes open, and could not for about an hour be brought to attend to the ſtimulus of external objects by any kind of violence, which it was proper to uſe: theſe ſymptoms returned in this order every day for five or ſix weeks.

Theſe converſations were quite conſiſtent, and we could underſtand, what ſhe ſuppoſed her imaginary companions to anſwer, by the continuation of her part of the diſcourſe. Sometimes ſhe was angry, at other times ſhewed much wit and vivacity, but was moſt frequently inclined to melancholy. In theſe reveries ſhe ſometimes ſung over ſome muſic with accuracy, and repeated whole pages from the Engliſh poets. In repeating ſome lines from Mr. Pope's works ſhe had forgot one word, and began again, endeavouring to recollect it; when ſhe came to the forgotten word, it was ſhouted aloud in her ear, and this repeatedly to no purpoſe; but by many trials ſhe at length regained it herſelf.

Theſe paroxyſms were terminated with the appearance of inexpreſſible ſurpriſe, and great fear, from which ſhe was ſome minutes in recovering herſelf, calling on her ſiſter with great agitation, and very frequently underwent a repetition of convulſions,

apprently

apparently from the pain of fear. See Sect. XVII. 3. 7.

After having thus returned for about an hour every day for two or three weeks, the reveries ſeemed to become leſs complete, and ſome of their circumſtances varied; ſo that ſhe could walk about the room in them without running againſt any of the furniture; though theſe motions were at firſt very unſteady and tottering. And afterwards ſhe once drank a diſh of tea, when the whole apparatus of the tea-table was ſet before her; and expreſſed ſome ſuſpicion, that a medicine was put into it, and once ſeemed to ſmell of a tuberoſe, which was in flower in her chamber, and deliberated aloud about breaking it from the ſtem, ſaying, "it would make her ſiſter ſo charmingly angry." At another time in her melancholy moments ſhe heard the ſound of a paſſing bell, "I wiſh I was dead," ſhe cried, liſtening to the bell, and then taking off one of her ſhoes, as ſhe ſat upon the bed, "I love the colour black," ſays ſhe, "a little wider, and a little longer, even this might make me a coffin!"—Yet it is evident, ſhe was not ſenſible at this time, any more than formerly, of ſeeing or hearing any perſon about her; indeed when great light was thrown upon her by opening the ſhutters of the window, her trains of ideas ſeemed leſs melancholy; and when I have forcibly held her hands, or covered her eyes, ſhe appeared to grow impatient, and would ſay, ſhe could not tell what to do, for ſhe could neither ſee nor move. In all theſe circumſtances her pulſe continued unaffected as in health. And when the paroxyſm was over, ſhe could never recollect a ſingle idea of what had paſſed in it.

This aſtoniſhing diſeaſe, after the uſe of many other medicines and applications in vain, was cured by very large doſes of opium given about an hour before

before the expected returns of the paroxyſms; and after a few relapſes, at the intervals of three or four months, entirely diſappeared. But ſhe continued at times to have other ſymptoms of epilepſy.

3. We ſhall only here conſider, what had happened during the time of her reveries, as that is our preſent ſubject; the fits of convulſion belong to another part of this treatiſe. Sect. XXXIV. 44.

There ſeems to have been no ſuſpenſion of volition during the fits of reverie. becauſe ſhe endeavoured to regain the loſt idea in repeating the lines of poetry, and deliberated about breaking the tuberoſe and ſuſpected the tea to have been medicated.

4. The ideas and muſcular movements depending on ſenſation were exerted with their uſual vivacity, and were kept from being inconſiſtent by the power of volition, as appeared from her whole converſation, and was explained in Sect. XVII. 3. 7. and XVIII. 16.

5. The ideas and motions dependant on irritation during the firſt weeks of her diſeaſe, whilſt the reverie was complete, were never ſucceeded by the ſenſation of pleaſure or pain; as ſhe neither ſaw, heard, nor felt any of the ſurrounding objects. Nor was it certain that any irritative motions ſucceeded the ſtimulus of external objects, till the reverie became leſs complete, and then ſhe could walk about the room without running againſt the furniture of it. Afterwards, when the reverie became ſtill leſs complete from the uſe of opium, ſome few irritations were at times ſucceeded by her attention to them. As when ſhe ſmelt at a tuberoſe, and drank a diſh of tea, but this only when ſhe ſeemed voluntarily to attend to them.

6. In common life when we liſten to diſtant ſounds, or wiſh to diſtinguiſh objects in the night, we are obliged ſtrongly to exert our volition to diſpoſe the organs of ſenſe to perceive them, and

to ſuppreſs the other trains of ideas, which might interrupt theſe feeble ſenſations. Hence in the preſent hiſtory the ſtrongeſt ſtimuli were not perceived, except when the faculty of volition was exerted on the organ of ſenſe; and then even common ſtimuli were ſometimes perceived; for her mind was ſo ſtrenuouſly employed in purſuing its own trains of voluntary or ſenſitive ideas, that no common ſtimuli could ſo far excite her attention as to diſunite them; that is, the quantity of volition or of ſenſation already exiſting was greater than any, which could be produced in conſequence of common degrees of ſtimulation. But the few ſtimuli of the tuberoſe, and of the tea, which ſhe did perceive, were ſuch, as accidentally coincided with the trains of thought, which were paſſing in her mind; and hence did not diſunite thoſe trains, and create ſurpriſe. And their being perceived at all was owing to the power of volition preceding or coinciding with that of irritation.

This explication is countenanced by a fact mentioned concerning a ſomnambuliſt in the Lauſanne Tranſactions, who ſometimes opened his eyes for a ſhort time to examine, where he was, or where his ink-pot ſtood, and then ſhut them again, dipping his pen into the pot every now and then, and writing on, but never opening his eyes afterwards, although he wrote on from line to line regularly, and corrected ſome errors of the pen, or in ſpelling: ſo much eaſier was it to him to refer to his ideas of the poſitions of things, than to his perceptions of them.

7. The aſſociated motions perſiſted in their uſual channel, as appeared by the combinations of her ideas, and the uſe of her muſcles, and the equality of her pulſe; for the natural motions of the arterial ſyſtem, though originally excited like other motions by ſtimulus, ſeem in part to continue by their

their aſſociation with each other. As the heart of a viper pulſates long after it is cut out of the body, and removed from the ſtimulus of the blood.

8. In the ſection on ſleep, it was obſerved that the nerves of ſenſe are equally alive and ſuſceptible to irritation in that ſtate, as when we are awake; but that they are ſecluded from ſtimulating objects, or rendered unfit to receive them: but in complete reverie the reverſe happens, the immediate organs of ſenſe are expoſed to their uſual ſtimuli; but are either not excited into action at all, or not into ſo great action, as to produce attention or ſenſation.

The total forgetfulneſs of what paſſes in reveries; and the ſurpriſe on recovering from them, are explained in Section XVIII. 19. and in Section XVII. 3. 7.

9. It appears from hence, that reverie is a diſeaſe of the epileptic or cataleptic kind, ſince the paroxyſms of this young lady always began and frequently terminated with convulſions; and though in its greateſt degree it has been called ſomnambulation, or ſleep-walking, it is totally different from ſleep; becauſe the eſſential character of ſleep conſiſts in the total ſuſpenſion of volition, which in reverie is not affected; and the eſſential character of reverie conſiſts not in the abſence of thoſe irritative motions of our ſenſes, which are occaſioned by the ſtimulus of external objects, but in their never being productive of ſenſation. So that during a fit of reverie that ſtrange event happens to the whole ſyſtem of nerves, which occurs only to ſome particular branches of them in thoſe, who are a ſecond time expoſed to the action of contagious matter. If the matter of the ſmall-pox be inſerted into the arm of one, who has previouſly had that diſeaſe, it will ſtimulate the wound, but the general ſenſation or inflammation of the ſyſtem does not follow, which

which conſtitutes the diſeaſe. See Sect. XII. 7. 6. XXXIII. 2. 8.

10. The following is the definition or character of complete reverie. 1. The irritative motions occaſioned by internal ſtimuli continue, thoſe from the ſtimuli of external objects are either not produced at all, or are never ſucceeded by ſenſation or attention, unleſs they are at the ſame time excited by volition. 2. The ſenſitive motions continue, and are kept conſiſtent by the power of volition. 3. The voluntary motions continue undiſturbed. 4. The aſſociated motions continue undiſturbed.

Two other caſes of reverie are related in Section XXXIV. 3. which further evince, that reverie is an effort of the mind to relieve ſome painful ſenſation, and is hence allied to convulſion, and to inſanity. Another caſe is related in Claſs III. 1. 2. 2.

SECT. XX.

OF VERTIGO.

1. *We determine our perpendicularity by the apparent motions of objects. A person hood-winked cannot walk in a straight line. Dizziness on looking from a tower, in a room stained with uniform lozenges, on riding over snow.* 2. *Dizziness from moving objects. A whirling wheel. Fluctuations of a river. Experiment with a child.* 3. *Dizziness from our own motions and those of other objects. Riding over a broad stream. Sea-sickness.* 5. *Of turning round on one foot. Dervises in Turkey. Attention of the mind prevents slight sea-sickness. After a voyage ideas of vibratory motions are still perceived on shore.* 6. *Ideas continue some time after they are excited. Circumstances of turning on one foot, standing on a tower, and walking in the dark, explained.* 7. *Irritative ideas of apparent motions. Irritative ideas of sounds. Battement of the sound of bells and organ-pipes. Vertiginous noise in the head. Irritative motions of the stomach, intestines, and glands.* 8. *Symptoms that accompany vertigo. Why vomiting comes on in strokes of the palsy. By the motion of a ship. By injuries on the head. Why motion makes sick people vomit.* 9. *Why drunken people are vertiginous. Why a stone in the ureter, or bile-duct, produces vomiting.* 10. *Why after a voyage ideas of vibratory motions are perceived on shore.* 11. *Kinds of vertigo and their cure.* 12. *Definition of vertigo.*

1. IN learning to walk we judge of the distances of the objects, which we approach, by the eye; and by observing their perpendicularity determine our

our own. This circumſtance not having been attended to by the writers on viſion, the diſeaſe called vertigo or dizzineſs has been little underſtood.

When any perſon loſes the power of muſcular action, whether he is erect or in a ſitting poſture, he ſinks down upon the ground: as is ſeen in fainting fits, and other inſtances of great debility. Hence it follows, that ſome exertion of muſcular power is neceſſary to preſerve our perpendicular attitude. This is performed by proportionally exerting the antagoniſt muſcles of the trunk, neck, and limbs; and if at any time in our locomotions we find ourſelves inclining to one ſide, we either reſtore our equilibrium by the efforts of the muſcles on the other ſide, or by moving one of our feet extend the baſe, which we reſt upon, to the new center of gravity.

But the moſt eaſy and habitual manner of determining our want of perpendicularity, is by attending to the apparent motion of the objects within the ſphere of diſtinct viſion; for this apparent motion of objects, when we incline from our perpendiculatity, or begin to fall, is as much greater than the real motion of the eye, as the diameter of the ſphere of diſtinct viſion is to our perpendicular height.

Hence no one, who is hood-winked, can walk in a ſtraight line for a hundred ſteps together; for he inclines ſo greatly, before he is warned of his want of perpendicularity by the ſenſe of touch, not having the apparent motions of ambient objects to meaſure this inclination by, that he is neceſſitated to move one of his feet outwards, to the right or to the left, to ſupport the new centre of gravity, and thus errs from the line he endeavours to proceed in.

For the ſame reaſon many people become dizzy, when they look from the ſummit of a tower, which

is raiſed much above all other objects, as theſe objects are out of the ſphere of diſtinct viſion, and they are obliged to balance their bodies by the leſs accurate feelings of their muſcles.

There is another curious phenomenon belonging to this place, if the circumjacent viſible objects are ſo ſmall, that we do not diſtinguiſh their minute parts; or ſo ſimilar, that we do not know them from each other; we cannot determine our perpendicularity by them. Thus in a room hung with a paper, which is coloured over with ſimilar ſmall black lozenges or rhomboids, many people become dizzy; for when they begin to fall, the next and the next lozenge ſucceeds upon the eye; which they miſtake for the firſt, and are not aware, that they have any apparent motion. But if you fix a ſheet of paper, or draw any other figure, in the midſt of theſe lozenges, the charm ceaſes, and no dizzineſs is perceptible.—The ſame occurs, when we ride over a plain covered with ſnow without trees or other eminent objects.

2. But after having compared viſible objects at reſt with the ſenſe of touch, and learnt to diſtinguiſh their ſhapes and ſhades, and to meaſure our want of perpendicularity by their apparent motions, we come to conſider them in real motion. Here a new difficulty occurs, and we require ſome experience to learn the peculiar mode of motion of any moving objects, before we can make uſe of them for the purpoſes of determining our perpendicularity. Thus ſome people become dizzy at the ſight of a whirling wheel, or by gazing on the fluctuations of a river, if no ſteady objects are at the ſame time within the ſphere of their diſtinct viſion; and when a child firſt can ſtand erect upon his legs, if you gain his attention to a white handkerchief ſteadily extended like a ſail, and afterwards make it undulate, he inſtantly loſes his perpendicularity, and tumbles on the ground.

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3. A ſecond difficulty we have to encounter is to diſtinguiſh our own real movements from the apparent motions of objects. Our daily practice of walking and riding on horſeback ſoon inſtructs us with accuracy to diſcern theſe modes of motion, and to aſcribe the apparent motions of the ambient objects to ourſelves; but thoſe which we have not acquired by repeated habit, continue to confound us. So as we ride on horſeback the trees and cottages, which occur to us, appear at reſt; we can meaſure their diſtances with our eye, and regulate our attitude by them: yet if we careleſsly attend to diſtant hills or woods through a thin hedge, which is near us, we obſerve the jumping and progreſſive motions of them; as this is increaſed by the parallax of theſe objects; which we have not habituated ourſelves to attend to. When firſt an European mounts an elephant ſixteen feet high, and whoſe mode of motion he is not accuſtomed to, the objects ſeem to undulate, as he paſſes, and he frequently becomes ſick and vertiginous, as I am well informed. Any other unuſual movement of our bodies has the ſame effect, as riding backwards in a coach, ſwinging on a rope, turning round ſwiftly on one leg, ſcating on the ice, and a thouſand others. So after a patient has been long confined to his bed, when he firſt attempts to walk, he finds himſelf vertiginous, and is obliged by practice to learn again the particular modes of the apparent motions of objects, as he walks by them.

4. A third difficulty, which occurs to us in learning to balance ourſelves by the eye, is, when both ourſelves and the circumjacent objects are in real motion. Here it is neceſſary that we ſhould be habituated to both theſe modes of motion in order to preſerve our perpendicularity. Thus on horſeback we accurately obſerve another perſon whom we meet, trotting towards, without confounding his jumping and progreſſive motion with our own, be-

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cauſe we have been accuſtomed to them both; that is, to undergo the one, and to ſee the other at the ſame time. But in riding over a broad and fluctuating ſtream, though we are well experienced in the motions of our horſe, we are liable to become dizzy from our inexperience in that of the water. And when firſt we go on ſhip-board, where the movements of ourſelves, and the movements of the large waves are both new to us, the vertigo is almoſt unavoidable with the terrible ſickneſs, which attends it. And this I have been aſſured has happened to ſeveral from being removed from a large ſhip into a ſmall one; and again from a ſmall one into a man of war.

5. From the foregoing examples it is evident, that, when we are ſurrounded with unuſual motions, we loſe our perpendicularity: but there are ſome peculiar circumſtances attending this effect of moving objects, which we come now to mention, and ſhall hope from the recital of them to gain ſome inſight into the manner of their production.

When a child moves round quick upon one foot, the circumjacent objects become quite indiſtinct, as their diſtance increaſes their apparent motions; and this great velocity confounds both their forms, and their colours, as is ſeen in whirling round a many coloured wheel; he then loſes his uſual method of balancing himſelf by viſion, and begins to ſtagger, and attempts to recover himſelf by his muſcular feelings. This ſtaggering adds to the inſtability of the viſible objects by giving a vibratory motion beſides their rotatory one. This child then drops upon the ground, and the neighbouring objects ſeem to continue for ſome ſeconds of time to circulate around him, and the earth under him appears to librate like a balance. In ſome ſeconds of time theſe ſenſations of a continuation of the motion of objects vaniſh; but if he continues turning round

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ſomewhat longer, before he falls, ſickneſs and vomiting are very liable to ſucceed. But none of theſe circumſtances affect thoſe who have habituated themſelves to this kind of motion, as the derviſes in Turkey, amongſt whom theſe ſwift gyrations are a ceremony of religion.

In an open boat paſſing from Leith to Kinghorn in Scotland, a ſudden change of the wind ſhook the undiſtended ſail, and ſtopt our boat; from this unuſual movement the paſſengers all vomited except myſelf I obſerved, that the undulation of the ſhip, and the inſtability of all viſible objects, inclined me ſtrongly to be ſick; and this continued or increaſed, when I cloſed my eyes, but as often as I bent my attention with energy on the management and mechaniſm of the ropes and ſails, the ſickneſs ceaſed; and recurred again, as often as I relaxed this attention; and I am aſſured by a gentleman of obſervation and veracity, that he has more than once obſerved, when the veſſel has been in immediate danger, that the ſea-ſickneſs of the paſſengers has inſtantaneouſly ceaſed, and recurred again, when the danger was over.

Thoſe, who have been upon the water in a boat or ſhip ſo long, that they have acquired the neceſſary habits of motion upon that unſtable element, at their return on land frequently think in their reveries, or between ſleeping and waking, that they obſerve the room, they ſit in, or ſome of its furniture, to librate like the motion of the veſſel. This I have experienced myſelf, and have been told, that after long voyages, it is ſome time before theſe ideas entirely vaniſh. The ſame is obſervable in a leſs degree after having travelled ſome days in a ſtage coach, and particularly when we lie down in bed, and compoſe ourſelves to ſleep; in this caſe it is obſervable, that the rattling noiſe of the coach, as well as the undulatory motion, haunts

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us. The drunken vertigo, and the vulgar cuſtom of rocking children, will be conſidered in the next Section.

6. The motions, which are produced by the power of volition, may be immediately ſtopped by the exertion of the ſame power on the antagoniſt muſcles; otherwiſe theſe with all the other claſſes of motion continue to go on, ſome time after they are excited, as the palpitation of the heart continues after the object of fear, which occaſioned it, is removed. But this circumſtance is in no claſs of motions more remarkable than in thoſe dependent on irritation; thus if any one looks at the ſun, and then covers his eyes with his hand, he will for many ſeconds of time, perceive the image of the ſun marked on his retina: a ſimilar image of all other viſible objects would remain ſome time formed on the retina, but is extinguiſhed by the perpetual change of the motions of this nerve in our attention to other objects. To this muſt be added, that the longer time any movements have continued to be excited without fatigue to the organ, the longer will they continue ſpontaneouſly, after the excitement is withdrawn: as the taſte of tobacco in the mouth after a perſon has been ſmoaking it. This taſte remains ſo ſtrong, that if a perſon continues to draw air through a tobacco pipe in the dark, after having been ſmoking ſome time, he cannot diſtinguiſh whether his pipe be lighted or not.

From theſe two conſiderations it appears, that the dizzineſs felt in the head, after ſeeing objects in unuſual motion, is no other than a continuation of the motions of the optic nerve excited by thoſe objects, and which engage our attention. Thus on turning round on one foot, the vertigo continues for ſome ſeconds of time after the perſon is fallen on the ground; and the longer he has continued

to revolve, the longer will continue these ſucceſſive motions of the parts of the optic nerve. See an additional note at the end of this volume.

Any one who ſtands alone on the top of a high tower, if he has not been accuſtomed to balance himſelf by objects placed at ſuch diſtances and with ſuch inclinations, begins to ſtagger, and endeavours to recover himſelf by his muſcular feelings. During this time the apparent motion of objects at a diſtance below him is very great, and the ſpectra of theſe apparent motions continue a little time after he has experienced them; and he is perſuaded to incline the contrary way to counteract their effects; and either immediately falls, or applying his hands to the building, uſes his muſcular feelings to preſerve his perpendicular attitude, contrary to the erroneous perſuaſions of his eyes. Whilſt the perſon, who walks in the dark, ſtaggers, but without dizzineſs; for he neither has the ſenſation of moving objects to take off his attention from his muſcular feelings, nor has he the ſpectra of thoſe motions continued on his retina to add to his confuſion. It happens indeed ſometimes to one ſtanding on a tower, that the idea of his not having room to extend his baſe by moving one of his feet outwards when he begins to incline, ſuperadds fears to his other inconveniences; which like ſurpriſe, joy, or any great degree of ſenſation, enervates him in a moment, by employing the whole ſenſorial power, and by thus breaking all the aſſociated trains and tribes of motion.

7. The irritative ideas of objects, whilſt we are awake, are perpetually preſent to our ſenſe of ſight; as we view the furniture of our rooms, or the ground, we tread upon, throughout the whole day without attending to it. And as our bodies are never at perfect reſt during our waking hours, theſe irritative ideas of objects are attended perpetually

tually with irritative ideas of their apparent motions. The ideas of apparent motions are always irritative ideas, becauſe we never attend to them, whether we attend to the objects themſelves, or to their real motions, or to neither. Hence the ideas of the apparent motions of objects are a complete circle of irritative ideas, which continue throughout the day.

Alſo during all our waking hours, there is a perpetual confuſed ſound of various bodies, as of the wind in our rooms, the fire, diſtant converſations, mechanic buſineſs; this continued buzz, as we are ſeldom quite motionleſs, changes its loudneſs perpetually, like the ſound of a bell; which riſes and falls as long as it continues, and ſeems to pulſate on the ear. Thus any one may experience by turning himſelf round near a waterfall; or by ſtriking a glaſs bell, and then moving the direction of its mouth towards the ears, or from them, as long as its vibrations continue. Hence this undulation of indiſtinct ſound makes another concomitant circle of irritative ideas, which continues throughout the day.

We hear this undulating ſound, when we are perfectly at reſt ourſelves, from other ſonorous bodies beſides bells; as from two organ-pipes, which are nearly but not quite in uniſon, when they are ſounded together. When a bell is ſtruck, the circular form is changed into an elliptic one; the longeſt axis of which, as the vibrations continue, moves round the periphery of the bell; and when either axis of this ellipſe is pointed towards our ears, the ſound is louder; and leſs when the intermediate parts of the ellipſe are oppoſite to us. The vibrations of the two organ-pipes may be compared to Nonius's rule; the ſound is louder, when they coincide, and leſs at the intermediate times. But, as the ſound of bells is the moſt

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familiar of thoſe ſounds, which have a conſiderable battement, the vertiginous patients, who attend to the irritative circles of ſounds above deſcribed, generally compare it to the noiſe of bells.

The periſtaltic motions of our ſtomach and inteſtines, and the ſecretions of the various glands, are other circles of irritative motions, ſome of them more or leſs complete, according to our abſtinence or ſatiety.

So that the irritative ideas of the apparent motions of objects, the irritative battements of ſounds, and the movements of our bowels and glands compoſe a great circle of irritative tribes of motion: and when one conſiderable part of this circle of motions becomes interrupted, the whole proceeds in confuſion, as deſcribed in Section XVII. 1. 7. on Catenation of Motions.

8. Hence a violent vertigo, from whatever cauſe it happens, is generally attended with undulating noiſe in the head, perverſions of the motions of the ſtomach and duodenum, unuſual excretion of bile and gaſtric juice, with much pale urine, ſometimes with yellowneſs of the ſkin, and a diſordered ſecretion of almoſt every gland of the body, till at length the arterial ſyſtem is affected, and fever ſucceeds.

Thus bilious vomitings accompany the vertigo occaſioned by the motion of a ſhip; and when the brain is rendered vertiginous by a paralytic affection of any part of the body, a vomiting generally enſues, and a great diſcharge of bile: and hence great injuries of the head from external violence are ſucceeded with bilious vomitings, and ſometimes with abſceſſes of the liver. And hence, when a patient is inclined to vomit from other cauſes, as in ſome fevers, any motions of the attendants in his room, or of himſelf when he is raiſed

raiſed or turned in his bed, preſently induce the vomiting by ſuperadding a degree of vertigo.

9. And converſely it is very uſual with thoſe, whoſe ſtomachs are affected from internal cauſes, to be afflicted with vertigo, and noiſe in the head; ſuch is the vertigo of drunken people, which continues, when their eyes are cloſed, and themſelves in a recumbent poſture, as well as when they are in an erect poſture, and have their eyes open. And thus the irritation of a ſtone in the bile-duct, or in the ureter, or an inflammation of any of the inteſtines, are accompanied with vomitings and vertigo.

In theſe caſes the irritative motions of the ſtomach, which are in general not attended to, become ſo changed by ſome unnatural ſtimulus, as to become uneaſy, and excite our ſenſation or attention. And thus the other irritative trains of motions, which are aſſociated with it, become diſordered by their ſympathy. The ſame happens, when a piece of gravel ſticks in the ureter, or when ſome part of the inteſtinal canal becomes inflamed. In theſe caſes the irritative muſcular motions are firſt diſturbed by unuſual ſtimulus, and a diſordered action of the ſenſual motions, or dizzineſs enſues. While in ſea-ſickneſs the irritative ſenſual motions, as vertigo, precedes; and the diſordered irritative muſcular motions, as thoſe of the ſtomach in vomiting, follow.

10. When theſe irritative motions are diſturbed, if the degree be not very great, the exertion of voluntary attention to any other object, or any ſudden ſenſation, will diſjoin theſe new habits of motion. Thus ſome drunken people have become ſober immediately, when any accident has ſtrongly excited their attention; and ſea-ſickneſs has vaniſhed, when the ſhip has been in danger. Hence when our attention to other objects is moſt relaxed,

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as juſt before we fall aſleep, or between our reveries when awake, theſe irritative ideas of motion and ſound are moſt liable to be perceived; as thoſe who have been at ſea, or have travelled long in a coach, ſeem to perceive the vibrations of the ſhip, or the rattling of the wheels, at theſe intervals; which ceaſe again, as ſoon as they exert their attention. That is, at thoſe intervals they attend to the apparent motions, and to the battement of ſounds of the bodies around them, and for a moment miſtake them for thoſe real motions of the ſhip, and noiſe of wheels, which they had lately been accuſtomed to: or at theſe intervals of reverie, or on the approach of ſleep, theſe ſuppoſed motions or ſounds may be produced entirely by imagination.

We may conclude from this account of vertigo, that ſea-ſickneſs is not an effort of nature to relieve herſelf, but a neceſſary conſequence of the aſſociations or catenations of animal motions. And may thence infer, that the vomiting, which attends the gravel in the ureter, inflammations of the bowels, and the commencement of ſome fevers, has a ſimilar origin, and is not always an effort of the vis medicatrix naturæ. But where the action of the organ is the immediate conſequence of the ſtimulating cauſe, it is frequently exerted to diſlodge that ſtimulus, as in vomiting up an emetic drug; at other times, the action of an organ is a general effort to relieve pain, as in convulſions of the locomotive muſcles; other actions drink up and carry on the fluids, as in abſorption and ſecretion; all which may be termed efforts of nature to relieve, or to preſerve herſelf.

11. The cure of vertigo will frequently depend on our previouſly inveſtigating the cauſe of it, which from what has been delivered above may originate from the diſorder of any part of the great tribes of irritative

irritative motions, and of the aſſociate motions catenated with them.

Many people, when they arrive at fifty or ſixty years of age, are affected with ſlight vertigo; which is generally but wrongly aſcribed to indigeſtion, but in reality ariſes from a beginning defect of their ſight; as about this time they alſo find it neceſſary to begin to uſe ſpectacles, when they read ſmall prints, eſpecially in winter, or by candle light, but are yet able to read without them during the ſummer days, when the light is ſtronger. Theſe people do not ſee objects ſo diſtinctly as formerly, and by exerting their eyes more than uſual, they perceive the apparent motions of objects, and confound them with the real motions of them; and therefore cannot accurately balance themſelves ſo as eaſily to preſerve their perpendicularity by them.

That is, the apparent motions of objects, which are at reſt, as we move by them, ſhould only excite irritative ideas: but as theſe are now become leſs diſtinct, owing to the beginning imperfection of our ſight, we are induced *voluntarily* to attend to them; and then theſe apparent motions become ſucceeded by ſenſation; and thus the other parts of the trains of irritative ideas, or irritative muſcular motions, become diſordered, as explained above. In theſe caſes of ſlight vertigo I have always promiſed my patients, that they would get free from it in two or three months, as they ſhould acquire the habit of balancing their bodies by leſs diſtinct objects, and have ſeldom been miſtaken in my prognoſtic.

There is an auditory vertigo, which is called a noiſe in the head, explained in No. 7. of this ſection, which alſo is very liable to affect people in the advance of life, and is owing to their hearing leſs perfectly than before. This is ſometimes called a ringing

tinging, and ſometimes a ſinging, or buzzing, in the ears, and is occaſioned by our firſt experiencing a diſagreeable ſenſation from our not being able diſtinctly to hear the ſounds, we uſed formerly to hear diſtinctly. And this diſagreeable ſenſation excites deſire and conſequent volition; and when we voluntarily attend to ſmall indiſtinct ſounds, even the whiſpering of the air in a room, and the pulſations of the arteries of the ear are ſucceeded by ſenſation; which minute ſounds ought only to have produced irritative ſenſual motions, or unperceived ideas. See Section XVII. 3. 6. Theſe patients after a while loſe this auditory vertigo, by acquiring a new habit of not attending voluntarily to theſe indiſtinct ſounds, but contenting themſelves with the leſs accuracy of their ſenſe of hearing.

Another kind of vertigo begins with the diſordered action of ſome irritative muſcular motions, as thoſe of the ſtomach from intoxication, or from emetics; or thoſe of the ureter, from the ſtimulus of a ſtone lodged in it; and it is probable, that the diſordered motions of ſome of the great congeries of glands, as of thoſe which form the liver, or of the inteſtinal canal, may occaſion vertigo in conſequence of their motions being aſſociated or catenated with the great circles of irritative motions; and from hence it appears, that the means of cure muſt be adapted to the cauſe.

To prevent ſea-ſickneſs it is probable, that the habit of ſwinging for a week or two before going on ſhipboard might be of ſervice. For the vertigo from failure of ſight, ſpectacles may be uſed. For the auditory vertigo, æther may be dropt into the ear to ſtimulate the part, or to diſſolve ear-wax, if ſuch be a part of the cauſe. For the vertigo ariſing from indigeſtion, the peruvian bark and a bliſter are recommended. And for that owing to a ſtone

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in the ureter, venesection, cathartics, opiates, sal soda aerated.

12. Definition of vertigo. 1. Some of the irritative sensual, or muscular motions, which were usually not succeeded by sensation, are in this disease succeeded by sensation; and the trains or circles of motions, which were usually catenated with them, are interrupted, or inverted, or proceed in confusion. 2. The sensitive and voluntary motions continue undisturbed. 3. The associate trains or circles of motions continue; but their catenations with some of the irritative motions are disordered, or inverted, or dissevered.

SECT.

SECT. XXI.

OF DRUNKENNESS.

1. *Sleep from ſatiety of hunger. From rocking children. From uniform ſounds.* 2. *Intoxication from common food after fatigue and inanition.* 3. *From wine or opium. Chilneſs after meals. Vertigo. Why pleaſure is produced by intoxication, and by ſwinging and rocking children. And why pain is relieved by it.* 4. *Why drunkards ſtagger and ſtammer, and are liable to weep.* 5. *And become delirious, ſleepy, and ſtupid.* 6. *Or make pale urine and vomit.* 7. *Objects are ſeen double.* 8. *Attention of the mind diminiſhes drunkenneſs.* 9. *Diſordered irritative motions of all the ſenſes.* 10. *Diſeaſes from drunkenneſs.* 11. *Definition of drunkenneſs.*

1. IN the ſtate of nature when the ſenſe of hunger is appeaſed by the ſtimulus of agreeable food, the buſineſs of the day is over, and the human ſavage is at peace with the world, he then exerts little attention to external objects, pleaſing reveries of imagination ſucceed, and at length ſleep is the reſult: till the nouriſhment which he has procured, is carried over every part of the ſyſtem to repair the injuries of action, and he awakens with freſh vigour, and feels a renewal of his ſenſe of hunger.

The juices of ſome bitter vegetables, as of the poppy and the lauro-ceraſus, and the ardent ſpirit produced in the fermentation of the ſugar found in vegetable juices, are ſo agreeable to the nerves of the ſtomach, that, taken in a ſmall quantity, they inſtantly pacify the ſenſe of hunger; and the inattention to external ſtimuli with the reveries of imagi-

nation, and ſleep, ſucceeds, in the ſame manner as when the ſtomach is filled with other leſs intoxicating food.

This inattention to the irritative motions occaſioned by external ſtimuli is a very important circumſtance in the approach of ſleep, and is produced in young children by rocking their cradles: during which all viſible objects become indiſtinct to them. An uniform ſoft repeated ſound, as the murmurs of a gentle current, or of bees, are ſaid to produce the ſame effect, by preſenting indiſtinct ideas of inconſequential ſounds, and by thus ſtealing our attention from other objects, whilſt by their continued reiterations they become familiar themſelves, and we ceaſe gradually to attend to any thing, and ſleep enſues.

2. After great fatigue or inanition, when the ſtomach is ſuddenly filled with fleſh and vegetable food, the inattention to external ſtimuli, and the reveries of imagination, become ſo conſpicuous as to amount to a degree of intoxication. The ſame is at any time produced by ſuperadding a little wine or opium to our common meals; or by taking theſe ſeparately in conſiderable quantity; and this more efficaciouſly after fatigue or inanition; becauſe a leſs quantity of any ſtimulating material will excite an organ into energetic action, after it has lately been torpid from defect of ſtimulus; as objects appear more luminous, after we have been in the dark; and becauſe the ſuſpenſion of volition, which is the immediate cauſe of ſleep, is ſooner induced, after a continued voluntary exertion has in part exhauſted the ſenſorial power of volition; in the ſame manner as we cannot contract a ſingle muſcle long together without intervals of inaction.

3. In the beginning of intoxication we are inclined to ſleep, as mentioned above, but by the excitement of external circumſtances, as of noiſe, light, buſineſs,

buſineſs, or by the exertion of volition, we prevent the approaches of it, and continue to take into our ſtomach greater quantities of the inebriating materials. By theſe means the irritative movements of the ſtomach are excited into greater action than is natural: and in conſequence all the irritative tribes and trains of motion, which are catenated with them, become ſuſceptible of ſtronger action from their accuſtomed ſtimuli; becauſe theſe motions are excited both by their uſual irritation, and by their aſſociation with the increaſed actions of the ſtomach and lacteals. Hence the ſkin glows, and the heat of the body is increaſed, by the more energetic action of the whole glandular ſyſtem; and pleaſure is introduced in conſequence of theſe increaſed motions from internal ſtimulus. According to Law 5. Sect. IV. on Animal Cauſation.

From this great increaſe of irritative motions from internal ſtimulus, and the increaſed ſenſation introduced into the ſyſtem in conſequence; and ſecondly, from the increaſed ſenſitive motions in conſequence of this additional quantity of ſenſation, ſo much ſenſorial power is expended, that the voluntary power becomes feebly exerted, and the irritation from the ſtimulus of external objects is leſs forcible; the external parts of the eye are not therefore voluntarily adapted to the diſtances of objects, whence the apparent motions of thoſe objects either are ſeen double, or become too indiſtinct for the purpoſe of balancing the body, and vertigo is induced.

Hence we become acquainted with that very curious circumſtance, why the drunken vertigo is attended with an increaſe of pleaſure; for the irritative ideas and motions occaſioned by internal ſtimulus, that were not attended to in our ſober hours, are now juſt ſo much increaſed as to be ſucceeded by pleaſurable ſenſation, in the ſame manner as the more violent motions of our organs are ſucceeded by

painful ſenſation. And hence a greater quantity of pleaſurable ſenſation is introduced into the conſtitution; which is attended in ſome people with an increaſe of benevolence and good humour.

If the apparent motions of objects is much increaſed, as when we revolve on one foot, or are ſwung on a rope, the ideas of theſe apparent motions are alſo attended to, and are ſucceeded with pleaſurable ſenſation, till they become familiar to us by frequent uſe. Hence children are at firſt delighted with theſe kinds of exerciſe, and with riding, and ſailing, and hence rocking young children inclines them to ſleep. For though in the vertigo from intoxication the irritative ideas of the apparent motions of objects are indiſtinct from their decreaſe of energy: yet in the vertigo occaſioned by rocking or ſwinging the irritative ideas of the apparent motions of objects are increaſed in energy, and hence they induce pleaſure into the ſyſtem, but are equally indiſtinct, and in conſequence equally unfit to balance ourſelves by. This addition of pleaſure precludes deſire or averſion, and in conſequence the voluntary power is feebly exerted, and on this account rocking young children inclines them to ſleep.

In what manner opium and wine act in relieving pain is another article, that well deſerves our attention. There are many pains that originate from defect as well as from exceſs of ſtimulus; of theſe are thoſe of the ſix appetites of hunger, thirſt, luſt, the want of heat, of diſtention, and of freſh air. Thus if our cutaneous capillaries ceaſe to act from the diminiſhed ſtimulus of heat, when we are expoſed to cold weather, or our ſtomach is uneaſy for want of food; theſe are both pains from defect of ſtimulus, and in conſequence opium, which ſtimulates all the moving ſyſtem into increaſed action, muſt relieve them. But this is not the caſe in thoſe pains, which ariſe from exceſs of ſtimulus, as in violent inflammations:

tions: in these the exhibition of opium is frequently injurious by increasing the action of the system already too great, as in inflammation of the bowels mortification is often produced by the stimulus of opium. Where, however, no such bad consequences follow; the stimulus of opium, by increasing all the motions of the system, expends so much of the sensorial power, that the actions of the whole system soon become feebler, and in consequence those which produced the pain and inflammation.

4. When intoxication proceeds a little further, the quantity of pleasurable sensation is so far increased, that all desire ceases, for there is no pain in the system to excite it. Hence the voluntary exertions are diminished, staggering and stammering succeed; and the trains of ideas become more and more inconsistent from this defect of voluntary exertion, as explained in the sections on sleep and reverie, whilst those passions which are unmixed with volition are more vividly felt, and shewn with less reserve; hence pining love, or superstitious fear, and the maudlin tear dropped on the remembrance of the most trifling distress.

5. At length all these circumstances are increased; the quantity of pleasure introduced into the system by the increased irritative muscular motions of the whole sanguiferous, and glandular, and absorbent systems, becomes so great, that the organs of sense are more forcibly excited into action by this internal pleasurable sensation, than by the irritation from the stimulus of external objects Hence the drunkard ceases to attend to external stimuli, and as volition is now also suspended, the trains of his ideas become totally inconsistent as in dreams, or delirium: and at length a stupor succeeds from the great exhaustion of sensorial power, which probably does not even admit of dreams, and in which, as in apoplexy, no motions continue but those from internal stimuli, from sensation, and from association.

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6. In other people a paroxyſm of drunkenneſs has another termination; the inebriate, as ſoon as he begins to be vertiginous, makes pale urine in great quantities and very frequently, and at length becomes ſick, vomits repeatedly, or purges, or has profuſe ſweats, and a temporary fever enſues with a quick ſtrong pulſe. This in ſome hours is ſucceeded by ſleep; but the unfortunate bacchanalian does not perfectly recover himſelf till about the ſame time of the ſucceeding day, when his courſe of inebriation began. As ſhewn in Sect. XVII. 1. 7. on Catenation. The temporary fever with ſtrong pulſe is owing to the ſame cauſe as the glow on the ſkin mentioned in the third paragraph of this Section: the flow of urine and ſickneſs ariſes from the whole ſyſtem of irritative motions being thrown into confuſion by their aſſociations with each other; as in ſea-ſickneſs, mentioned in Sect. XX. 4. on Vertigo: and which is more fully explained in Sect. XXIX. on Diabetes.

7. In this vertigo from internal cauſes we ſee objects double, as two candles inſtead of one, which is thus explained. Two lines drawn through the axes of our two eyes meet at the object we attend to: this angle of the optic axes increaſes or diminiſhes with the leſs or greater diſtances of objects. All objects before or behind the place where this angle is formed, appear double; as any one may obſerve by holding up a pen between his eyes and the candle; when he looks attentively at a ſpot on the pen, and careleſsly at the candle, it will appear double; and the reverſe when he looks attentively at the candle and careleſsly at the pen; ſo that in this caſe the muſcles of the eye, like thoſe of the limbs, ſtagger and are diſobedient to the expiring efforts of volition. Numerous objects are indeed ſometimes ſeen by the inebriate, occaſioned by the refractions made by the tears, which ſtand upon his eye-lids.

8. This

8. This vertigo also continues, when the inebriate lies in his bed, in the dark, or with his eyes closed; and this more powerfully than when he is erect, and in the light. For the irritative ideas of the apparent motions of objects are now excited by irritation from internal stimulus, or by association with other irritative motions; and the inebriate, like one in a dream, believes the objects of these irritative motions to be present, and feels himself vertiginous. I have observed in this situation, so long as my eyes and mind were intent upon a book, the sickness and vertigo ceased, and were renewed again the moment I discontinued this attention; as was explained in the preceding account of sea-sickness. Some drunken people have been known to become sober instantly from some accident, that has strongly excited their attention, as the pain of a broken bone, or the news of their house being on fire.

9. Sometimes the vertigo from internal causes, as from intoxication, or at the beginning of some fevers, becomes so universal, that the irritative motions which belong to other organs of sense are succeeded by sensation or attention, as well as those of the eye. The vertiginous noise in the ears has been explained in Sect. XX. on Vertigo. The taste of the saliva, which in general is not attended to, becomes perceptible, and the patients complain of a bad taste in their mouth.

The common smells of the surrounding air sometimes excite the attention of these patients, and bad smells are complained of, which to other people are imperceptible. The irritative motions that belong to the sense of pressure, or of touch, are attended to, and the patient conceives the bed to librate, and is fearful of falling out of it. The irritative motions belonging to the senses of distention, and of heat, like those above mentioned, become attended to at this time: hence we feel the pulsation of our arteries all over us, and complain of heat, or of cold in parts of the body where there is no accumulation or diminution of actual heat. All which

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are to be explained, as in the laſt paragraph, by the irritative ideas belonging to the various ſenſes being now excited by internal ſtimuli, or by their aſſociations with other irritative motions. And that the inebriate, like one in a dream, believes the external objects, which uſually cauſed theſe irritative ideas, to be now preſent.

10. The diſeaſes in conſequence of frequent inebriety, or of daily taking much vinous ſpirit without inebriety, conſiſt in the paralyſis which is liable to ſucceed violent ſtimulation. Organs, whoſe actions are aſſociated with others, are frequently more affected than the organ, which is ſtimulated into too violent action. See Sect. XXIV. 2. 8. Hence in drunken people it generally happens, that the ſecretory veſſels of the liver become firſt paralytic, and a torpor with conſequent gall-ſtones or ſchirrus of this viſcus is induced with concomitant jaundice; otherwiſe it becomes inflamed in conſequence of previous torpor, and this inflammation is frequently transferred to a more ſenſible part, which is aſſociated with it, and produces the gout, or the roſy eruption of the face, or ſome other leprous eruption on the head, or arms, or legs. Sometimes the ſtomach is firſt affected, and paralyſis of the lacteal ſyſtem is induced: whence a total abhorrence from fleſh-food, and general emaciation. In others the lymphatic ſyſtem is affected with paralyſis, and dropſy is the conſequence. In ſome inebriates the torpor of the liver produces pain without apparent ſchirrus, or gall-ſtones, or inflammation, or conſequent gout, and in theſe epilepſy or inſanity are often the conſequence. All which will be more fully treated of in the courſe of this work.

I am well aware that it is a common opinion, that the gout is as frequently owing to gluttony in eating, as to intemperance in drinking fermented or ſpirituous liquors. To this I anſwer, that I have ſeen

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no perſon afflicted with the gout, who has not drank freely of fermented liquor, as wine and water, or ſmall beer: though as the diſpoſition to all the diſeaſes, which have originated from intoxication, is in ſome degree hereditary, a leſs quantity of ſpirituous potation will induce the gout in thoſe, who inherit the diſpoſition from their parents. To which I muſt add, that in young people the rheumatiſm is frequently miſtaken for the gout.

Spice is ſeldom taken in ſuch quantity as to do any material injury to the ſyſtem, fleſh meats as well as vegetables are the natural diet of mankind; with theſe a glutton may be crammed up to the throat, and fed like a ſtalled ox; but he will not be diſeaſed, unleſs he adds ſpirituous or fermented liquor to his food. This is well known in the diſtilleries, where the ſwine, which are fattened by the ſpirituous ſediments of barrels, acquire diſeaſed livers. But mark what happens to a man, who drinks a quart of wine or of ale, if he has not been habituated to it. He loſes the uſe both of his limbs and of his underſtanding! He becomes a temporary idiot, and has a temporary ſtroke of the palſy! And though he ſlowly recovers after ſome hours, is it not reaſonable to conclude, that a perpetual repetition of ſo powerful a poiſon muſt at length permanently affect him? If a perſon accidentally becomes intoxicated by eating a few muſhrooms of a peculiar kind, a general alarm is excited, and he is ſaid to be poiſoned, and emetics are exhibited; but ſo familiariſed are we to the intoxication from vinous ſpirit, that it occaſions laughter rather than alarm.

There is however conſiderable danger in too haſtily diſcontinuing the uſe of ſo ſtrong a ſtimulus, leſt the torpor of the ſyſtem, or paralyſis, ſhould ſooner be induced by the omiſſion than the continuance of this habit, when unfortunately acquired. A golden rule for determining the quantity, which may with

ſafety

ſafety be diſcontinued, is delivered in Section XII. 7. 8.

11. Definition of drunkenneſs. Many of the irritative motions are much increaſed in energy by internal ſtimulation.

2. A great additional quantity of pleaſurable ſenſation is occaſioned by this increaſed exertion of the irritative motions. And many ſenſitive motions are produced in conſequence of this increaſed ſenſation.

3. The aſſociated trains and tribes of motions, catenated with the increaſed irritative and ſenſitive motions, are diſturbed, and proceed in confuſion.

4. The faculty of volition is gradually impaired, whence proceeds the inſtability of locomotion, inaccuracy of perception, and inconſiſtency of ideas; and is at length totally ſuſpended, and a temporary apoplexy ſucceeds.

SECT.

SECT. XXII.

OF PROPENSITY TO MOTION, REPETITION AND IMITATION.

I. *Accumulation of ſenſorial power in hemiplagia, in ſleep, in cold fit of fever, in the locomotive muſcles, in the organs of ſenſe. Produces propenſity to action.* II. *Repetition by three ſenſorial powers. In rhimes and alliterations, in muſic, dancing, architecture, landſcape-painting, beauty.* III. 1. *Perception conſiſts in imitation. Four kinds of imitation.* 2. *Voluntary. Dogs taught to dance.* 3. *Senſitive. Hence ſympathy and all our virtues. Contagious matter of venereal ulcers, of hydrophobia, of jail-fever, of ſmall-pox, produced by imitation, and the ſex of the embryon.* 4. *Irritative imitation.* 5. *Imitations reſolvable into aſſociations.*

I. 1. IN the hemiplagia, when the limbs on one ſide have loſt their power of voluntary motion, the patient is for many days perpetually employed in moving thoſe of the other. 2. When the voluntary power is ſuſpended during ſleep, there commences a ceaſeleſs flow of ſenſitive motions, or ideas of imagination, which compoſe our dreams. 3. When in the cold fit of an intermittent fever ſome parts of the ſyſtem have for a time continued torpid, and have thus expended leſs than their uſual expenditure of ſenſorial power; a hot fit ſucceeds, with violent action of thoſe veſſels, which had previouſly been quieſcent. All theſe are explained from an accumulation of ſenſorial power during the inactivity of ſome part of the ſyſtem.

Beſides the very great quantity of ſenſorial power perpetually produced and expanded in moving the arterial,

arterial, venous, and glandular ſyſtems, with the various organs of digeſtion, as deſcribed in Section XXXII. 3. 2, there is alſo a conſtant expenditure of it by the action of our locomotive muſcles and organs of ſenſe. Thus the thickneſs of the optic nerves, where they enter the eye, and the great expanſion of the nerves of touch beneath the whole of the cuticle, evince the great conſumption of ſenſorial power by theſe ſenſes. And our perpetual muſcular actions in the common offices of life, and in conſtantly preſerving the perpendicularity of our bodies during the day, evince a conſiderable expenditure of the ſpirit of animation by our locomotive muſcles. It follows, if the exertion of theſe organs of ſenſe and muſcles be for a while intermitted, that ſome portion of ſenſorial power muſt be accumulated, and a propenſity to activity of ſome kind enſue from the increaſed excitability of the ſyſtem. Whence proceeds the irkſomeneſs of a continued attitude, and of an indolent life.

However ſmall this hourly accumulation of the ſpirit of animation may be, it produces a propenſity to ſome kind of action; but it nevertheleſs requires either deſire or averſion, either pleaſure or pain, or ſome external ſtimulus, or a previous link of aſſociation, to excite the ſyſtem into activity; thus it frequently happens, when the mind and body are ſo unemployed as not to poſſeſs any of the three firſt kinds of ſtimuli, that the laſt takes place, and conſumes the ſmall but perpetual accumulation of ſenſorial power. Whence ſome indolent people repeat the ſame verſe for hours together, or hum the ſame tune. Thus the poet:

> Onward he trudged, not knowing what he ſought,
> And whiſtled as he went, for want of thought.

II. The

II. The repetitions of motions may be at firſt produced either by volition, or by ſenſation, or by irritation, but they ſoon become eaſier to perform than any other kinds of action, becauſe they ſoon become aſſociated together, according to Law the ſeventh, Section IV. on Animal Cauſation. And becauſe their frequency of repetition, if as much ſenſorial power be produced during every reiteration as is expended, adds to the facility of their production.

If a ſtimulus be repeated at uniform intervals of time, as deſcribed in Section XII. 3. 3. the action, whether of our muſcles or organs of ſenſe, is produced with ſtill greater facility or energy; becauſe the ſenſorial power of aſſociation mentioned above, is combined with the ſenſorial power of irritation; that is, in common language, the acquired habit aſſiſts the power of the ſtimulus.

This not only obtains in the annual, lunar, and diurnal catenations of animal motions, as explained in Section XXXVI., which are thus performed with great facility and energy; but in every leſs circle of actions or ideas, as in the burthen of a ſong, or the reiterations of a dance. To the facility and diſtinctneſs, with which we hear ſounds at repeated intervals, we owe the pleaſure, which we receive from muſical time, and from poetic time; as deſcribed in Botanic Garden, P. 2. Interlude 3. And to this the pleaſure we receive from the rhimes and alliterations of modern verſification; the ſource of which without this key would be difficult to diſcover. And to this likewiſe ſhould be aſcribed the beauty of the duplicature in the perfect tenſe of the Greek verbs, and of ſome Latin ones, as tango tetigi, mordeo momordi.

There is no variety of notes referable to the gamut in the beating of the drum, yet if it be performed in muſical time, it is agreeable to our ears; and

and therefore this pleaſurable ſenſation muſt be owing to the repetition of the diviſions of the ſounds at certain intervals of time, or muſical bars. Whether theſe times or bars are diſtinguiſhed by a pauſe, or by an emphaſis or accent, certain it is, that this diſtinction is perpetually repeated; otherwiſe the ear could not determine inſtantly, whether the ſucceſſions of ſound were in common or in triple time. In common time there is a diviſion between every two crotchets, or other notes of equivalent time; though the bar in written muſic is put after every fourth crotchet, or notes equivalent in time; in triple time the diviſion or bar is after every three crotchets, or notes equivalent; ſo that in common time the repetition recurs more frequently than in triple time. The grave or heroic verſes of the Greek and Latin poets are written in common time; the French heroic verſes, and Mr. Anſtie's humorous verſes in his Bath Guide, are written in the ſame time as the Greek and Latin verſes, but are one bar ſhorter. The Engliſh grave or heroic verſes are meaſured by triple time, as Mr. Pope's tranſlation of Homer.

But beſides theſe little circles of muſical time, there are the greater returning periods, and the ſtill more diſtant choruſes, which like the rhimes at the ends of verſes, owe their beauty to repetition; that is, to the facility and diſtinctneſs with which we perceive ſounds, which we expect to perceive, or have perceived before; or in the language of this work, to the greater eaſe and energy with which our organ is excited by the combined ſenſorial powers of aſſociation and irritation, than by the latter ſingly.

A certain uniformity or repetition of parts enters the very compoſition of harmony. Thus two octaves neareſt to each other in the ſcale commence their vibrations together after every ſecond vibration of the higher one. And where the firſt, third, and fifth compoſe a chord, the vibrations concur or coincide

cide frequently, though leſs ſo than in the two octaves. It is probable that theſe chords bear ſome analogy to a mixture of three alternate colours in the ſun's ſpectrum ſeparated by a priſm.

The pleaſure we receive from a melodious ſucceſſion of notes referable to the gamut is derived from another ſource, viz. to the pandiculation or counteraction of antagoniſt fibres. See Botanic Garden, P. 2. Interlude 3. If to theſe be added our early aſſociations of agreeable ideas with certain proportions of ſound, I ſuppoſe, from theſe three ſources ſprings all the delight of muſic, ſo celebrated by ancient authors, and ſo enthuſiaſtically cultivated at preſent. See Sect. XVI. No. 10. on Inſtinct.

This kind of pleaſure ariſing from repetition, that is from the facility and diſtinctneſs, with which we perceive and underſtand repeated ſenſations, enters into all the agreeable arts; and when it is carried to exceſs is termed formality. The art of dancing like that of muſic depends for a great part of the pleaſure, it affords, on repetition; architecture, eſpecially the Grecian, conſiſts of one part being a repetition of another; and hence the beauty of the pyramidal outline in landſcape-painting; where one ſide of the picture may be ſaid in ſome meaſure to balance the other. So univerſally does repetition contribute to our pleaſure in the fine arts, that beauty itſelf has been defined by ſome writers to conſiſt in a due combination of uniformity and variety. See Sect. XVI. 6.

III. 1. Man is termed by Ariſtotle an imitative animal; this propenſity to imitation not only appears in the actions of children, but in all the cuſtoms and faſhions of the world: many thouſands tread in the beaten paths of others, for one who traverſes regions of his own diſcovery. The origin of this propenſity of imitation has not, that I recollect, been deduced from any known principle; when any action

tion preſents itſelf to the view of a child, as of whetting a knife, or threading a needle, the parts of this action in reſpect of time, motion, figure, are imitated by a part of the retina of his eye; to perform this action therefore with his hands is eaſier to him than to invent any new action, becauſe it conſiſts in repeating with another ſet of fibres, viz. with the moving muſcles, what he had juſt performed by ſome part of the retina; juſt as in dancing we transfer the times of motion from the actions of the auditory nerves to the muſcles of the limbs. Imitation therefore conſiſts of repetition, which we have ſhewn above to be the eaſieſt kind of animal action, and which we perpetually fall into, when we poſſeſs an accumulation of ſenſorial power, which is not otherwiſe called into exertion.

It has been ſhewn, that our ideas are configurations of the organs of ſenſe, produced originally in conſequence of the ſtimulus of external bodies. And that theſe ideas, or configurations of the organs of ſenſe, reſemble in ſome property a correſpondent property of external matter; as the parts of the ſenſes of ſight and of touch, which are excited into action, reſemble in figure the figure of the ſtimulating body; and probably alſo the colour, and the quantity of denſity, which they perceive. As explained in Sect. XIV. 2. 2. Hence it appears, that our perceptions themſelves are copies, that is, imitations of ſome properties of external matter; and the propenſity to imitation is thus interwoven with our exiſtence, as it is produced by the ſtimuli of external bodies, and is afterwards repeated by our volitions and ſenſations, and thus conſtitutes all the operations of our minds.

2. Imitations reſolve themſelves into four kinds, voluntary, ſenſitive, irritative, and aſſociate. The voluntary imitations are, when we imitate deliberately the actions of others, either by mimicry, as in acting a play,

play, or in delineating a flower; or in the common actions of our lives, as in our dreſs, cookery, language, manners, and even in our habits of thinking.

Not only the greateſt part of mankind learn all the common arts of life by imitating others, but brute animals ſeem capable of acquiring knowledge with greater facility by imitating each other, than by any methods by which we can teach them; as dogs and cats, when they are ſick, learn of each other to eat graſs; and I ſuppoſe, that by making an artificial dog perform certain tricks, as in dancing on his hinder legs, a living dog might be eaſily induced to imitate them; and that the readieſt way of inſtructing dumb animals is by practiſing them with others of the ſame ſpecies, which have already learned the arts we wiſh to teach them. The important uſe of imitation in acquiring natural language is mentioned in Sect. XVI. 7. and 8. on Inſtinct.

3. The ſenſitive imitations are the immediate conſequences of pleaſure or pain, and theſe are often produced even contrary to the efforts of the will. Thus many young men on ſeeing cruel ſurgical operations become ſick, and ſome even feel pain in the parts of their own bodies, which they ſee tortured or wounded in others; that is, they in ſome meaſure imitate by the exertions of their own fibres the violent actions, which they witneſſed in thoſe of others. In this caſe a double imitation takes place, firſt the obſerver imitates with the extremities of the optic nerve the mangled limbs, which are preſent before his eyes; then by a ſecond imitation he excites ſo violent action of the fibres of his own limbs as to produce pain in thoſe parts of his own body, which he ſaw wounded in another. In theſe pains produced by imitation the effect has ſome ſimilarity to the cauſe, which diſtinguiſhes them from thoſe produced by aſſociation; as the pains of the teeth, called tooth-edge, which

are produced by aſſociation with diſagreeable ſounds, as explained in Sect. XVI. 10.

The effect of this powerful agent, imitation, in the moral world, is mentioned in Sect. XVI. 7. as it is the foundation of all our intellectual ſympathies with the pains and pleaſures of others, and is in conſequence the ſource of all our virtues. For in what conſiſts our ſympathy with the miſeries, or with the joys, of our fellow creatures, but in an involuntary excitation of ideas in ſome meaſure ſimilar or imitative of thoſe, which we believe to exiſt in the minds of the perſons, whom we commiſerate or congratulate?

There are certain concurrent or ſucceſſive actions of ſome of the glands, or other parts of the body, which are poſſeſſed of ſenſation, which become intelligible from this propenſity to imitation. Of theſe are the production of matter by the membranes of the fauces, or by the ſkin, in conſequence of the venereal diſeaſe previouſly affecting the parts of generation. Since as no fever is excited, and as neither the blood of ſuch patients, nor even the matter from ulcers of the throat, or from cutaneous ulcers, will by inoculation produce the venereal diſeaſe in others, as obſerved by Mr. Hunter, there is reaſon to conclude, that no contagious matter is conveyed thither by the blood-veſſels, but that a milder matter is formed by the actions of the fine veſſels in thoſe membranes imitating each other. See Sect. XXXIII. 2. 9. In this diſeaſe the actions of theſe veſſels producing ulcers on the throat and ſkin are imperfect imitations of thoſe producing chancre, or gonorrhœa; ſince the matter produced by them is not infectious, while the imitative actions in the hydrophobia appear to be perfect reſemblances, as they produce a material equally infectious with the original one, which induced them.

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The contagion from the bite of a mad dog differs from other contagious materials, from its being communicable from other animals to mankind, and from many animals to each other; the phænomena attending the hydrophobia are in ſome degree explicable on the foregoing theory. The infectious matter does not appear to enter the circulation, as it cannot be traced along the courſe of the lymphatics from the wound, nor is there any ſwelling of the lymphatic glands, nor does any fever attend, as occurs in the ſmall-pox, and in many other contagious diſeaſes; yet by ſome unknown proceſs the diſeaſe is communicated from the wound to the throat, and that many months after the injury, ſo as to produce pain and hydrophobia, with a ſecretion of infectious ſaliva of the ſame kind, as that of the mad dog, which inflicted the wound.

This ſubject is very intricate.—It would appear, that by certain morbid actions of the ſalivary glands of the mad dog, a peculiar kind of ſaliva is produced; which being inſtilled into a wound of another animal, ſtimulates the cutaneous or mucous glands into morbid actions, but which are ineffectual in reſpect to the production of a ſimilar contagious material; but the ſalivary glands by irritative ſympathy are thrown into ſimilar action, and produce an infectious ſaliva ſimilar to that inſtilled into the wound.

Though in many contagious fevers a material ſimilar to that which produced the diſeaſe, is thus generated by imitation; yet there are other infectious materials, which do not thus propagate themſelves, but which ſeem to act like ſlow poiſons. Of this kind was the contagious matter, which produced the jail-fever at the aſſizes at Oxford about a century ago. Which, though fatal to many, was not communicated to their nurſes or attendants. In theſe caſes, the imitations of the fine veſſels as above deſcribed, appear to be imperfect, and do not therefore

produce a matter ſimilar to that, which ſtimulates them; in this circumſtance reſembling the venereal matter in ulcers of the throat or ſkin, according to the curious diſcovery of Mr. Hunter above related, who found, by repeated inoculations, that it would not infect. Hunter on Venereal Diſeaſe, Part vi. ch. 1.

Another example of morbid imitation is in the production of a great quantity of contagious matter, as in the inoculated ſmall-pox, from a ſmall quantity of it inſerted into the arm, and probably diffuſed in the blood. Theſe particles of contagious matter ſtimulate the extremities of the fine arteries of the ſkin, and cauſe them to imitate ſome properties of thoſe particles of contagious matter, ſo as to produce a thouſandfold of a ſimilar material. See Section XXXIII. 2. 6. Other inſtances are mentioned in the Section on Generation, which ſhew the probability that the extremities of the ſeminal glands may imitate certain ideas of the mind, or actions of the organs of ſenſe, and thus occaſion the male or female ſex of the embryon. See Sect. XXXIX. 6.

4. We come now to thoſe imitations, which are not attended with ſenſation. Of theſe are all the irritative ideas already explained, as when the retina of the eye imitates by its action or configuration the tree or the bench, which I ſhun in walking paſt without attending to them. Other examples of theſe irritative imitations are daily obſervable in common life; thus one yawning perſon ſhall ſet a whole company a yawning; and ſome have acquired winking of the eyes or impediments of ſpeech by imitating their companions without being conſcious of it.

5. Beſides the three ſpecies of imitations above deſcribed there may be ſome aſſociate motions, which may imitate each other in the kind as well as in the quantity of their action; but it is difficult to diſtinguiſh them from the aſſociations of motions treated

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of in Section XXXV. Where the actions of other perſons are imitated, there can be no doubt, or where we imitate a preconceived idea by exertion of our locomotive muſcles, as in painting a dragon; all theſe imitations may aptly be referred to the ſources above deſcribed of the propenſity to activity, and the facility of repetition; at the ſame time I do not affirm, that all thoſe other apparent ſenſitive and irritative imitations may not be reſolvable into aſſociations of a peculiar kind, in which certain diſtant parts of ſimilar irritability or ſenſibility, and which have habitually acted together, may affect each other exactly with the ſame kinds of motion; as many parts are known to ſympathiſe in the quantity of their motions. And that therefore they may be ultimately reſolvable into aſſociations of action, as deſcribed in Sect. XXXV.

SECT.

SECT. XXIII.

OF THE CIRCULATORY SYSTEM.

I. The heart and arteries have no antagoniſt muſcles. Veins abſorb the blood, propel it forwards, and diſtend the heart; contraction of the heart diſtends the arteries. Vena portarum. II. *Glands which take their fluids from the blood. With long necks, with ſhort necks.* III. *Abſorbent ſyſtem.* IV. *Heat given out from glandular ſecretions. Blood changes colour in the lungs and in the glands and capillaries.* V. *Blood is abſorbed by veins, as chyle by lacteal veſſels, otherwiſe they could not join their ſtreams.* VI. *Two kinds of ſtimulus, agreeable and diſagreeable. Glandular appetency. Glands originally poſſeſſed ſenſation.*

I. WE now ſtep forwards to illuſtrate ſome of the phænomena of diſeaſes, and to trace out their moſt efficacious methods of cure; and ſhall commence this ſubject with a ſhort deſcription of the circulatory ſyſtem.

As the nerves, whoſe extremities form our various organs of ſenſe and muſcles, are all joined, or communicate, by means of the brain, for the convenience perhaps of the diſtribution of a ſubtile etherial fluid for the purpoſe of motion; ſo all thoſe veſſels of the body, which carry the groſſer fluids for the purpoſes of nutrition, communicate with each other by the heart.

The heart and arteries are hollow muſcles, and are therefore indued with power of contraction in conſequence of ſtimulus, like all other muſcular fibres; but, as they have no antagoniſt muſcles, the cavities of the veſſels, which they form, would remain

main for ever cloſed, after they have contracted themſelves, unleſs ſome extraneous power be applied to again diſtend them. This extraneous power in reſpect to the heart is the current of blood, which is perpetually abſorbed by the veins from the various glands and capillaries, and puſhed into the heart by a power probably very ſimilar to that, which raiſes the ſap in vegetables in the ſpring, which, according to Dr. Hale's experiment on the ſtump of a vine, exerted a force equal to a column of water above twenty feet high. This force of the current of blood in the veins is partly produced by their abſorbent power, exerted at the beginning of every fine ramification; which may be conceived to be a mouth abſorbing blood, as the mouths of the lacteals and lymphatics abſorb chyle and lymph. And partly by their intermitted compreſſion by the pulſations of their generally concomitant arteries; by which the blood is perpetually propelled towards the heart, as the valves in many veins, and the abſorbent mouths in them all, will not ſuffer it to return.

The blood, thus forcibly injected into the chambers of the heart, diſtends this combination of hollow muſcles; till by the ſtimulus of diſtention they contract themſelves; and, puſhing forwards the blood into the arteries, exert ſufficient force to overcome in leſs than a ſecond of time the vis inertiæ, and perhaps ſome elaſticity, of the very extenſive ramifications of the two great ſyſtems of the aortal and pulmonary arteries. The power neceſſary to do this in ſo ſhort a time muſt be conſiderable, and has been variouſly eſtimated by different phyſiologiſts.

The muſcular coats of the arterial ſyſtem are then brought into action by the ſtimulus of diſtention, and propel the blood to the mouths, or through the convolutions,

convolutions, which precede the ſecretory apertures of the various glands and capillaries.

In the veſſels of the liver there is no intervention of the heart; but the vena portarum, which does the office of an artery, is diſtended by the blood poured into it from the meſenteric veins, and is by this diſtention ſtimulated to contract itſelf, and propel the blood to the mouths of the numerous glands, which compoſe that viſcus.

II. The glandular ſyſtem of veſſels may be divided into thoſe, which take ſome fluid from the circulation; and thoſe, which give ſomething to it. Thoſe, which take their fluid from the circulation are the various glands, by which the tears, bile, urine, perſpiration, and many other ſecretions are produced; theſe glands probably conſiſt of a mouth to ſelect, a belly to digeſt, and an excretory aperture to emit their appropriated fluids; the blood is conveyed by the power of the heart and arteries to the mouths of theſe glands, it is there taken up by the living power of the gland, and carried forwards to its belly, and excretory aperture, where a part is ſeparated, and the remainder abſorbed by the veins for further purpoſes.

Some of theſe glands are furniſhed with long convoluted necks or tubes, as the ſeminal ones, which are curiouſly ſeen when injected with quickſilver. Others ſeem to conſiſt of ſhorter tubes, as that great congeries of glands which conſtitute the liver, and thoſe of the kidneys Some have their excretory apartures opening into reſervoirs, as the urinary and gall bladders. And others on the external body, as thoſe which ſecrete the tears, and perſpirable matter.

Another great ſyſtem of glands, which have very ſhort necks, are the capillary veſſels; by which the inſenſible perſpiration is ſecreted on the ſkin; and

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the mucus of various conſiſtencies, which lubricates the interſtices of the cellular membrane, of the muſcular fibres, and of all the larger cavities of the body. From the want of a long convolution of veſſels ſome have doubted, whether theſe capillaries ſhould be conſidered as glands, and have been led to conclude, that the perſpirable matter rather exuded than was ſecreted. But the fluid of perſpiration is not ſimple water, though that part of it which exhales into the air may be ſuch; for there is a part of it, which in a ſtate of health is abſorbed again; but which, when the abſorbents are diſeaſed, remains on the ſurface of the ſkin, in the form of ſcurf, or indurated mucus. Another thing, which ſhews their ſimilitude to other glands, is their ſenſibility to certain affections of the mind; as is ſeen in the deeper colour of the ſkin in the bluſh of ſhame, or the greater paleneſs of it from fear.

III. Another ſeries of glandular veſſels is called the abſorbent ſyſtem; theſe open their mouths into all the cavities, and upon all thoſe ſurfaces of the body, where the excretory apertures of the other glands pour out their fluids. The mouths of the abſorbent ſyſtem drink up a part or the whole of theſe fluids, and carry them forwards by their living power to their reſpective glands, which are called conglobate glands. There theſe fluids undergo ſome change, before they paſs on into the circulation; but if they are very acrid, the conglobate gland ſwells, and ſometime ſuppurates, as in inoculation of the ſmall-pox, in the plague, and in venereal abſorptions; at other times the fluid may perhaps continue there, till it undergoes ſome chemical change, that renders it leſs noxious; or, what is more likely, till it is regurgitated by the retrograde motion of the gland in ſpontaneous ſweats or diarrhœas

rhœas, as diſagreeing food is vomited from the ſtomach.

IV. As all the fluids, that paſs through theſe glands, and capillary veſſels, undergo a chemical change, acquiring new combinations, the matter of heat is at the ſame time given out; this is apparent, ſince whatever increaſes inſenſible perſpiration, increaſes the heat of the ſkin; and when the action of theſe veſſels is much increaſed but for a moment, as in bluſhing, a vivid heat on the ſkin is the immediate conſequence. So when great bilious ſecretions, or thoſe of any other gland, are produced, heat is generated in the part in proportion to the quantity of the ſecretion.

The heat produced on the ſkin by bluſhing may be thought by ſome too ſudden to be pronounced a chemical effect, as the fermentations or new combinations taking place in a fluid is in general a ſlower proceſs. Yet are there many chemical mixtures in which heat is given out as inſtantaneouſly; as in ſolutions of metals in acids, or in mixtures of eſſential oils and acids, as of oil of cloves and acid of nitre. So the bruiſed parts of an unripe apple become almoſt inſtantaneouſly ſweet; and if the chemico-animal proceſs of digeſtion be ſtopped for but a moment, as by fear, or even by voluntary eructation, a great quantity of air is generated, by the fermentation which inſtantly ſucceeds the ſtop of digeſtion. By the experiments of Dr. Hales it appears, that an apple during fermentation gave up above ſix hundred times its bulk of air; and the materials in the ſtomach are ſuch, and in ſuch a ſituation, as immediately to run into fermentation, when digeſtion is impeded.

As the blood paſſes through the ſmall veſſels of the lungs, which connect the pulmonary artery and vein, it undergoes a change of colour from a dark to a light

a light red: which may be termed a chemical change, as it is known to be effected by an admixture of oxygene, or vital air; which, according to a diſcovery of Dr. Prieſtley, paſſes through the moiſt membranes, which conſtitute the ſides of theſe veſſels. As the blood paſſes through the capillary veſſels, and glands, which connect the aorta and its various branches with their correſpondent veins in the extremities of the body, it again loſes the bright red colour, and undergoes ſome new combinations in the glands or capillaries, in which the matter of heat is given out from the ſecreted fluids. This proceſs therefore, as well as the proceſs of reſpiration, has ſome analogy to combuſtion, as the vital air or oxygene ſeems to become united to ſome inflammable baſe, and the matter of heat eſcapes from the new acid, which is thus produced.

V. After the blood has paſſed theſe glands and capillaries and parted with whatever they choſe to take from it, the remainder is received by the veins, which are a ſet of blood-abſorbing veſſels in general correſponding with the ramifications of the arterial ſyſtem. At the extremity of the fine convolutions of the glands the arterial force ceaſes; this in reſpect to the capillary veſſels, which unite the extremities of the arteries with the commencement of the veins, is evident to the eye, on viewing the tail of a tadpole by means of a ſolar, or even by a common microſcope, for globules of blood are ſeen to endeavour to paſs, and to return again and again, before they become abſorbed by the mouths of the veins; which returning of theſe globules evinces, that the arterial force behind them has ceaſed. The veins are furniſhed with valves like the lymphatic abſorbents; and the great trunks of the veins, and of the lacteals and lymphatics, join together before the ingreſs of their fluids into the left chamber of the heart; both which

which evince that the blood in the veins, and the lymph and chyle in the lacteals and lymphatics, are carried on by a ſimilar force; otherwiſe the ſtream, which was propelled with a leſs power, could not enter the veſſels, which contained the ſtream propelled with a greater power. From whence it appears, that the veins are a ſyſtem of veſſels abſorbing blood, as the lacteals and lymphatics are a ſyſtem of veſſels abſorbing chyle and lymph. See Section XXVI. 1.

VI. The movements of their adapted fluids in the various veſſels of the body are carried forwards by the actions of thoſe veſſels in conſequence of two kinds of ſtimulus, one of which may be compared to a pleaſurable ſenſation or deſire inducing the veſſel to ſeize, and, as it were, to ſwallow the particles thus ſelected from the blood; as is done by the mouths of the various glands, veins, and other abſorbents, which may be called glandular appetency. The other kind of ſtimulus may be compared to diſagreeable ſenſation or averſion, as when the heart has received the blood, and is ſtimulated by it to puſh it forwards into the arteries; the ſame again ſtimulates the arteries to contract, and carry forwards the blood to their extremities, the glands and capillaries. Thus the meſenteric veins abſorb the blood from the inteſtines by glandular appetency, and carry it forward to the vena portarum; which acting as an artery contracts itſelf by diſagreeable ſtimulus, and puſhes it to its ramified extremities, the various glands, which conſtitute the liver.

It ſeems probable, that at the beginning of the formation of theſe veſſels in the embryon, an agreeable ſenſation was in reality felt by the glands during ſecretion, as is now felt in the act of ſwallowing palatable food; and that a diſagreeable ſenſation was originally felt by the heart from the diſtention occaſioned

ſioned by the blood, or by its chemical ſtimulus; but that by habit theſe are all become irritative motions; that is, ſuch motions as do not affect the whole ſyſtem, except when the veſſels are diſeaſed by inflammation.

SECT.

SECT. XXIV.

OF THE SECRETIONS OF SALIVA, AND OF TEARS, AND OF THE LACRYMAL SACK.

I. *Secretion of ſaliva increaſed by mercury in the blood.* 1. *By the food in the mouth. Dryneſs of the mouth not from a deficiency of ſaliva.* 2. *By ſenſitive ideas.* 3. *By volition.* 4. *By diſtaſteful ſubſtances. It is ſecreted in a dilute and ſaline ſtate. It then becomes more viſcid.* 5. *By ideas of diſtaſteful ſubſtances.* 6. *By nauſea.* 7. *By averſion.* 8. *By catenation with ſtimulating ſubſtances in the ear.* II. 1. *Secretion of tears leſs in ſleep. From ſtimulation of their excretory duct.* 2. *Lacrymal ſack is a gland.* 3. *Its uſes.* 4. *Tears are ſecreted when the naſal duct is ſtimulated.* 5. *Or when it is excited by ſenſation.* 6. *Or by volition.* 7. *The lacrymal ſack can regurgitate its contents into the eye.* 8. *More tears are ſecreted by aſſociation with the irritation of the naſal duct of the lacrymal ſack, than the puncta lacrymalia can imbibe. Of the gout in the liver and ſtomach.*

I. THE ſalival glands drink up a certain fluid from the circumfluent blood, and pour it into the mouth. They are ſometimes ſtimulated into action by the blood, that ſurrounds their origin, or by ſome part of that heterogeneous fluid: for when mercurial ſalts, or oxydes, are mixed with the blood, they ſtimulate theſe glands into unnatural exertions; and then an unuſual quantity of ſaliva is ſeparated.

As the ſaliva ſecreted by theſe glands is moſt wanted during the maſtication of our food, it happens, when the terminations of their ducts in the mouth are ſtimulated into action, the ſalival glands themſelves

themſelves are brought into increaſed action at the ſame time by aſſociation, and ſeparate a greater quantity of their juices from the blood; in the ſame manner as tears are produced in greater abundance during the ſtimulus of the vapour of onions, or of any other acrid material in the eye.

The ſaliva is thus naturally poured into the mouth only during the ſtimulus of our food in maſtication; for when there is too great an exhalation of the mucilaginous ſecretion from the membranes, which line the mouth, or too great an abſorption of it, the mouth becomes dry, though there is no deficiency in the quantity of ſaliva; as in thoſe who ſleep with their mouths open, and in ſome fevers.

2. Though during the maſtication of our natural food the ſalival glands are excited into action by the ſtimulus on their excretory ducts, and a due quantity of ſaliva is ſeparated from the blood, and poured into the mouth; yet as this maſtication of our food is always attended with a degree of pleaſure; and that pleaſurable ſenſation is alſo connected with our ideas of certain kinds of aliment: it follows, that when theſe ideas are reproduced, the pleaſurable ſenſation ariſes along with them, and the ſalival glands are excited into action, and fill the mouth with ſaliva from this ſenſitive aſſociation, as is frequently ſeen in dogs, who ſlaver at the ſight of food.

3. We have alſo a voluntary power over the action of theſe ſalival glands, for we can at any time produce a flow of ſaliva into our mouth, and ſpit out, or ſwallow it at will.

4. If any very acrid material be held in the mouth, as the root of pyrethrum, or the leaves of tobacco, the ſalival glands are ſtimulated into ſtronger action than is natural, and thence ſecrete a much larger quantity of ſaliva; which is at the ſame time more viſcid than in its natural ſtate; becauſe the lymphatics, that open their mouths into the ducts of the ſalival

ſalival glands, and on the membranes, which line the mouth, are likewiſe ſtimulated into ſtronger action, and abſorb the more liquid parts of the ſaliva with greater avidity; and the remainder is left both in greater quantity and more viſcid.

The increaſed abſorption in the mouth by ſome ſtimulating ſubſtances, which are called aſtringents, as crab juice, is evident from the inſtant dryneſs produced in the mouth by a ſmall quantity of them.

As the extremities of the glands are of exquiſite tenuity; as appears by their difficulty of injection, it was neceſſary for them to ſecrete their fluids in a very dilute ſtate; and probably for the purpoſe of ſtimulating them into action, a quantity of neutral ſalt is likewiſe ſecreted or formed by the gland. This aqueous and ſaline part of all ſecreted fluids is again reabſorbed into the habit. More than half of ſome ſecreted fluids is thus imbibed from the reſervoirs, into which they are poured; as in the urinary bladder much more than half of what is ſecreted by the kidneys becomes reabſorbed by the lymphatics, which are thickly diſperſed around the neck of the b adder. This ſeems to be the purpoſe of the urinary bladders of fiſh, as otherwiſe ſuch a receptacle for the urine could have been of no uſe to an animal immerſed in water.

5. The idea of ſubſtances diſagreeably acrid will alſo produce a quantity of ſaliva in the mouth; as when we ſmell very putrid vapours, we are induced to ſpit out our ſaliva, as if ſomething diſagreeable was actually upon our palates.

6. When diſagreeable food in the ſtomach produces nauſea, a flow of ſaliva is excited in the mouth by aſſociation; as efforts to vomit are frequently produced by diſagreeable drugs in the mouth by the

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7. A preternatural flow of ſaliva is likewiſe ſometimes occaſioned by a diſeaſe of the voluntary power; for if we think about our ſaliva, and determine not to ſwallow it, or not to ſpit it out, an exertion is produced by the will, and more ſaliva is ſecreted againſt our wiſh; that is, by our averſion, which bears the ſame analogy to deſire, as pain does to pleaſure; as they are only modifications of the ſame diſpoſition of the ſenſorium. See Claſs IV. 3. 2. 1.

8. The quantity of ſaliva may alſo be increaſed beyond what is natural, by the catenation of the motions of theſe glands with other motions, or ſenſations, as by an extraneous body in the ear; of which I have known an inſtance; or by the application of ſtizolobium, ſiliqua hirſuta, cowhage, to the ſeat of the parotis, as ſome writers have affirmed.

II. 1. The lacrymal gland drinks up a certain fluid from the circumfluent blood, and pours it on the ball of the eye, on the upper part of the external corner of the eyelids. Though it may perhaps be ſtimulated into the performance of its natural action by the blood, which ſurrounds its origin, or by ſome part of that heterogeneous fluid; yet as the tears ſecreted by this gland are more wanted at ſome times than at others, its ſecretion is variable, like that of the ſaliva above mentioned, and is chiefly produced when its excretory duct is ſtimulated; for in our common ſleep there ſeems to be little or no ſecretion of tears; though they are occaſionally produced by our ſenſations in dreams.

Thus when any extraneous material on the eyeball, or the dryneſs of the external covering of it, or the coldneſs of the air, or the acrimony of ſome vapours, as of onions, ſtimulates the excretory duct of the lacrymal gland, it diſcharges its contents upon the ball; a quicker ſecretion takes place in the gland, and abundant tears ſucceed, to moiſten, clean, and lubricate the eye. Theſe by frequent nictitation are

diffuſed over the whole ball, and as the external angle of the eye in winking is cloſed ſooner than the internal angle, the tears are gradually driven forwards, and downwards from the lacrymal gland to the puncta lacrymalia.

2. The lacrymal ſack, with its puncta lacrymalia, and its naſal duct, is a complete gland; and is ſingular in this reſpect, that it neither derives its fluid from, nor diſgorges it into the circulation. The ſimplicity of the ſtructure of this gland, and both the extremities of it being on the ſurface of the body, makes it well worthy our minuter obſervation; as the actions of more intricate and concealed glands may be better underſtood from their analogy to this.

3. This ſimple gland conſiſts of two abſorbing mouths, a belly, and an excretory duct. As the tears are brought to the internal angle of the eye, theſe two mouths drink them up, being ſtimulated into action by this fluid, which they abſorb. The belly of the gland, or lacrymal ſack, is thus filled, in which the ſaline part of the tears is abſorbed, and when the other end of the gland, or naſal duct, is ſtimulated by the dryneſs, or pained by the coldneſs of the air, or affected by any acrimonious duſt or vapour in the noſtrils, it is excited into action together with the ſack, and the tears are diſgorged upon the membrane, which lines the noſtrils; where they ſerve a ſecond purpoſe to moiſten, clean, and lubricate the organ of ſmell.

4. When the naſal duct of this gland is ſtimulated by any very acrid material, as the powder of tobacco, or volatile ſpirits, it not only diſgorges the contents of its belly or receptacle (the lacrymal ſack), and abſorbs haſtily all the fluid, that is ready for it in the corner of the eye; but by the aſſociation of its motions with thoſe of the lacrymal gland, it excites that alſo into increaſed action, and a large flow of tears is poured into the eye.

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5. This nasal duct is likewise excited into strong action by sensitive ideas, as in grief, or joy, and then also by its associations with the lacrymal gland it produces a great flow of tears without any external stimulus; as is more fully explained in Sect. XVI. 8. on Instinct.

6. There are some, famous in the arts of exciting compassion, who are said to have acquired a voluntary power of producing a flow of tears in the eye; which, from what has been said in the section on Instinct above mentioned, I should suspect, is performed by acquiring a voluntary power over the action of this nasal duct.

7. There is another circumstance well worthy our attention, that when by any accident this nasal duct is obstructed, the lacrymal sack, which is the belly or receptacle of this gland, by slight pressure of the finger is enabled to disgorge its contents again into the eye; perhaps the bile in the same manner, when the biliary ducts are obstructed, is returned into the blood by the vessels which secrete it?

8. A very important though minute occurrence must here be observed, that though the lacrymal gland is only excited into action, when we weep at a distressful tale, by its association with this nasal duct, as is more fully explained in Sect. XVI. 8; yet the quantity of tears secreted at once is more than the puncta lacrymalia can readily absorb; which shews *that the motions occasioned by associations are frequently more energetic than the original motions, by which they were occasioned.* Which we shall have occasion to mention hereafter, to illustrate, why pains frequently exist in a part distant from the cause of them, as in the other end of the urethra, when a stone stimulates the neck of the bladder. And why inflammations frequently arise in parts distant from their cause, as the gutta rosea of drinking people, from an inflamed liver.

The inflammation of a part is generally preceded by a torpor or quieſcence of it; if this exiſts in any large congeries of glands, as in the liver, or any membranous part, as the ſtomach, pain is produced and chillineſs in conſequence of the torpor of the veſſels. In this ſituation ſometimes an inflammation of the parts ſucceeds the torpor; at other times a diſtant more ſenſible part becomes inflamed; whoſe actions have previouſly been aſſociated with it; and the torpor of the firſt part ceaſes. This I apprehend happens, when the gout of the foot ſucceeds a pain of the biliary duct, or of the ſtomach. Laſtly, it ſometimes happens, that the pain of torpor exiſts without any conſequent inflammation of the affected part, or of any diſtant part aſſociated with it, as in the membranes about the temple and eye-brows in hemicrania, and in thoſe pains, which occaſion convulſions; if this happens to gouty people, when it affects the liver, I ſuppoſe epileptic fits are produced; and, when it affects the ſtomach, death is the conſequence. In theſe caſes the pulſe is weak, and the extremities cold, and ſuch medicines as ſtimulate the quieſcent parts into action, or which induce inflammation in them, or in any diſtant part, which is aſſociated with them, cures the preſent pain of torpor, and ſaves the patient.

I have twice ſeen a gouty inflammation of the liver, attended with jaundice; the patients after a few days were both of them affected with cold fits, like ague-fits, and their feet became affected with gout, and the inflammation of their livers ceaſed. It is probable, that the uneaſy ſenſations about the ſtomach, and indigeſtion which precedes gouty paroxyſms, are generally owing to torpor or ſlight inflammation of the liver, and biliary ducts; but where great pain with continued ſickneſs, with feeble pulſe, and ſenſation of cold, affect the

ſtomach

ſtomach in patients debilitated by the gout, that it is a torpor of the ſtomach itſelf, and deſtroys the patient from the great connexion of that viſcus with the vital organs. See Sect. XXV. 17.

SECT.

SECT. XXV.

OF THE STOMACH AND INTESTINES.

1. Of ſwallowing our food. Ruminating animals. 2. Action of the ſtomach. 3. Action of the inteſtines. Irritative motions connected with theſe. 4. Effects of repletion. 5. Stronger action of the ſtomach and inteſtines from more ſtimulating food. 6. Their action inverted by ſtill greater ſtimuli. Or by diſguſtful ideas. Or by volition. 7. Other glands ſtrengthen or invert their motions by ſympathy. 8. Vomiting performed by intervals. 9. Inverſion of the cutaneous abſorbents. 10. Increaſed ſecretion of bile and pancreatic juice. 11. Inverſion of the lacteals. 12. And of the bile-ducts. 13. Caſe of a cholera. 14. Further account of the inverſion of lacteals. 15. Iliac paſſions. Valve of the colon. 16. Cure of the iliac paſſion. 17. Pain of gall-ſtone diſtinguiſhed from pain of the ſtomach. Gout of the ſtomach from torpor, from inflammation. Intermitting pulſe owing to indigeſtion. To overdoſe of foxglove. Weak pulſe from emetics. Death from a blow on the ſtomach. From gout of the ſtomach.

1. THE throat, ſtomach, and inteſtines, may be conſidered as one great gland; which like the lacrymal ſack above mentioned, neither begins nor ends in the circulation. Though the act of maſticating our aliment belongs to the ſenſitive claſs of motions, for the pleaſure of its taſte induces the muſcles of the jaw into action; yet the deglutition of it when maſticated is generally, if not always, an irritative motion, occaſioned by the application of the food already maſticated to the origin of the pharynx;

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in the ſame manner as we often ſwallow our ſpittle without attending to it.

The ruminating claſs of animals have the power to invert the motion of their gullet, and of their firſt ſtomach, from the ſtimulus of this aliment, when it is a little further prepared; as is their daily practice in chewing the cud; and appears to the eye of any one, who attends to them, whilſt they are employed in the ſecond maſtication of their food.

2. When our natural aliment arrives into the ſtomach, this organ is ſtimulated into its proper vermicular action; which beginning at the upper orifice of it, and terminating at the lower one, gradually mixes together and puſhes forwards the digeſting materials into the inteſtine beneath it.

At the ſame time the glands, that ſupply the gaſtric juices, which are neceſſary to promote the chemical part of the proceſs of digeſtion, are ſtimulated to diſcharge their contained fluids, and to ſeparate a further ſupply from the blood-veſſels: and the lacteals or lymphatics, which open their mouths into the ſtomach, are ſtimulated into action, and take up ſome part of the digeſting materials.

3. The remainder of theſe digeſting materials is carried forwards into the upper inteſtines, and ſtimulates them into their periſtaltic motion ſimilar to that of the ſtomach; which continues gradually to mix the changing materials, and paſs them along through the valve of the colon to the excretory end of this great gland, the ſphincter ani.

The digeſting materials produce a flow of bile, and of pancreatic juice, as they paſs along the duodenum, by ſtimulating the excretory ducts of the liver and pancreas, which terminate in that inteſtine: and other branches of the abſorbent or lymphatic ſyſtem, called lacteals, are excited to drink up, as it paſſes, thoſe parts of the digeſting materials,

rials, that are proper for their purpoſe, by its ſtimulus on their mouths.

4. When the ſtomach and inteſtines are thus filled with their proper food, not only the motions of the gaſtric glands, the pancreas, liver, and lacteal veſſels, are excited into action; but at the ſame time the whole tribe of irritative motions are exerted with greater energy, a greater degree of warmth, colour, plumpneſs, and moiſture, is given to the ſkin from the increaſed action of thoſe glands called capillary veſſels; pleaſurable ſenſation is excited, the voluntary motions are leſs eaſily exerted, and at length ſuſpended; and ſleep ſucceeds, unleſs it be prevented by the ſtimulus of ſurrounding objects, or by voluntary exertion, or by an acquired habit, which was originally produced by one or other of theſe circumſtances, as is explained in Sect. XXI. on Drunkenneſs.

At this time alſo, as the blood-veſſels become replete with chyle, more urine is ſeparated into the bladder, and leſs of it is reabſorbed; more mucus poured into the cellular membranes, and leſs of it reabſorbed: the pulſe becomes fuller and ſofter, and in general quicker. The reaſon why leſs urine and cellular mucus is abſorbed after a full meal with ſufficient drink is owing to the blood-veſſels being fuller: hence one means to promote abſorption is to decreaſe the reſiſtance by emptying the veſſels by veneſection. From this decreaſed abſorption the urine becomes pale as well as copious, and the ſkin appears plump as well as florid.

By daily repetition of theſe movements they all become connected together, and make a diurnal circle of irritative action, and if one of this chain be diſturbed, the whole is liable to be put into diſorder. See Sect. XX. on Vertigo.

5. When the ſtomach and inteſtines receive a quantity of food, whoſe ſtimulus is greater than

uſual

uſual, all their motions, and thoſe of the glands and lymphatics, are ſtimulated into ſtronger action than uſual, and perform their offices with greater vigour and in leſs time: ſuch are the effects of certain quantities of ſpice or of vinous ſpirit.

6. But if the quantity or duration of theſe ſtimuli are ſtill further increaſed, the ſtomach and throat are ſtimulated into a motion, whoſe direction is contrary to the natural one above deſcribed; and they regurgitate the materials, which they contain, inſtead of carrying them forwards. This retrograde motion of the ſtomach may be compared to the ſtretchings of wearied limbs the contrary way, and is well elucidated by the following experiment. Look earneſtly for a minute or two on an area an inch ſquare of pink ſilk, placed in a ſtrong light, the eye becomes fatigued, the colour becomes faint, and at length vaniſhes, for the fatigued eye can no longer be ſtimulated into direct motions; then on cloſing the eye a green ſpectrum will appear in it, which is a colour directly contrary to pink, and which will appear and diſappear repeatedly, like the efforts in vomiting. See Section XXIX. 11.

Hence all thoſe drugs, which by their bitter or aſtringent ſtimulus increaſe the action of the ſtomach, as camomile and white vitriol, if their quantity is increaſed above a certain doſe, become emetics.

Theſe inverted motions of the ſtomach and throat are generally produced from the ſtimulus of unnatural food, and are attended with the ſenſation of nauſea or ſickneſs: but as this ſenſation is again connected with an idea of the diſtaſteful food, which induced it; ſo an idea of nauſeous food will alſo ſometimes excite the action of nauſea; and that give riſe by aſſociation to the inverſion of the motions of the ſtomach and throat. As ſome, who have had horſe-fleſh or dogs-fleſh given them for beef

beef or mutton, are ſaid to have vomited many hours afterwards, when they have been told of the impoſition.

I have been told of a perſon, who had gained a voluntary command over theſe inverted motions of the ſtomach and throat, and ſupported himſelf by exhibiting this curioſity to the public. At theſe exhibitions he ſwallowed a pint of red rough gooſeberries, and a pint of white ſmooth ones, brought them up in ſmall parcels into his mouth, and reſtored them ſeparately to the ſpectators, who called for red or white as they pleaſed, till the whole were re-delivered.

7. At the ſame time that theſe motions of the ſtomach and throat are ſtimulated into inverſion, ſome of the other irritative motions, that had acquired more immediate connexions with the ſtomach, as thoſe of the gaſtric glands, are excited into ſtronger action by this aſſociation; and ſome other of theſe motions, which are more eaſily excited, as thoſe of the gaſtric lymphatics, are inverted by their aſſociation with the retrograde motions of the ſtomach, and regurgitate their contents, and thus a greater quantity of mucus, and of lymph, or chyle, is poured into the ſtomach, and thrown up along with its contents.

8. Theſe inverſions of the motion of the ſtomach in vomiting are performed by intervals, for the ſame reaſon that many other motions are reciprocally exerted and relaxed; for during the time of exertion the ſtimulus, or ſenſation, which cauſed this exertion, is not perceived: but begins to be perceived again, as ſoon as the exertion ceaſes, and is ſome time in again producing its effect. As explained in Sect. XXXIV. on Volition, where it is ſhewn, that the contractions of the fibres, and the ſenſation of pain, which occaſioned that exertion, cannot exiſt at the ſame time. The exertion

ceaſes

ceaſes from another cauſe alſo, which is the exhauſtion of the ſenſorial power of the part, and theſe two cauſes frequently operate together.

9. At the times of theſe inverted efforts of the ſtomach not only the lymphatics, which open their mouths into the ſtomach, but thoſe of the ſkin alſo, are for a time inverted; for ſweats are ſometimes puſhed out during the efforts of vomiting without an increaſe of heat.

10. But if by a greater ſtimulus the motions of the ſtomach are inverted ſtill more violently or more permanently, the duodenum has its periſtaltic motions inverted at the ſame time by their aſſociation with thoſe of the ſtomach; and the bile and pancreatic juice, which it contains, are by the inverted motions brought up into the ſtomach, and diſcharged along with its contents; while a greater quantity of bile and pancreatic juice is poured into this inteſtine; as the glands, that ſecrete them, are by their aſſociation with the motions of the inteſtine excited into ſtronger action than uſual.

11. The other inteſtines are by aſſociation excited into more powerful action, while the lymphatics, that open their mouths into them, ſuffer an inverſion of their motions correſponding with the lymphatics of the ſtomach, and duodenum; which with a part of the abundant ſecretion of bile is carried downwards, and contributes both to ſtimulate the bowels, and to increaſe the quantity of the evacuations. This inverſion of the motion of the lymphatics appears from the quantity of chyle, which comes away by ſtools; which is otherwiſe abſorbed as ſoon as produced, and by the immenſe quantity of thin fluid, which is evacuated along with it.

12. But if the ſtimulus, which inverts the ſtomach, be ſtill more powerful, or more permanent, it ſometimes happens, that the motions of the biliary glands,

glands, and of their excretory ducts, are at the ſame time inverted, and regurgitate their contained bile into the blood veſſels, as appears by the yellow colour of the ſkin, and of the urine; and it is probable the pancreatic ſecretion may ſuffer an inverſion at the ſame time, though we have yet no mark by which this can be aſcertained.

13. Mr. ——— eat two putrid pigeons out of a cold pigeon-pye, and drank about a pint of beer and ale along with them, and immediately rode about five miles. He was then ſeized with vomiting, which was after a few periods ſucceeded by purging; theſe continued alternately for two hours; and the purging continued by intervals for ſix or eight hours longer. During this time he could not force himſelf to drink more than one pint in the whole; this great inability to drink was owing to the nauſea, or inverted motions of the ſtomach, which the voluntary exertion of ſwallowing could ſeldom and with difficulty overcome; yet he diſcharged in the whole at leaſt ſix quarts; whence came this quantity of liquid? Firſt, the contents of the ſtomach were emitted, then of the duodenum, gall-bladder, and pancreas, by vomiting. After this the contents of the lower bowels, then the chyle, that was in the lacteal veſſels, and in the receptacle of chyle, was regurgitated into the inteſtines by a retrograde motion of theſe veſſels. And afterwards the mucus depoſited in the cellular membrane, and on the ſurface of all the other membranes, ſeems to have been abſorbed; and with the fluid abſorded from the air to have been carried up their reſpective lymphatic branches by the increaſed energy of their natural motions, and down the viſceral lymphatics, or lacteals, by the inverſion of their motions.

14. It may be difficult to invent experiments to demonſtrate the truth of this inverſion of ſome branches

branches of the abſorbent ſyſtem, and increaſed abſorption of others, but the analogy of theſe veſſels to the inteſtinal canal, and the ſymptoms of many diſeaſes, render this opinion more probable than many other received opinions of the animal œconomy.

In the above inſtance, after the yellow excrement was voided, the fluid ceaſed to have any ſmell, and appeared like curdled milk, and then a thinner fluid, and ſome mucus, were evacuated; did not theſe ſeem to partake of the chyle, of the mucous fluid from all the cells of the body, and laſtly, of the atmoſpheric moiſture? All theſe facts may be eaſily obſerved by any one, who takes a briſk purge.

15. Where the ſtimulus on the ſtomach, or on ſome other part of the inteſtinal canal, is ſtill more permanent, not only the lacteal veſſels, but the whole canal itſelf, becomes inverted from its aſſociations: this is the iliac paſſion, in which all the fluids mentioned above are thrown up by the mouth. At this time the valve in the colon, from the inverted motions of that bowel, and the inverted action of this living valve, does not prevent the regurgitation of its contents.

The ſtructure of this valve may be repreſented by a flexile leathern pipe ſtanding up from the bottom of a veſſel of water: its ſides collapſe by the preſſure of the ambient fluid, as a ſmall part of that fluid paſſes through it; but if it has a living power, and by its inverted action keeps itſelf open, it becomes like a rigid pipe, and will admit the whole liquid to paſs. See Sect. XXIX. 2. 5.

In this caſe the patient is averſe to drink, from the conſtant inverſion of the motions of the ſtomach, and yet many quarts are daily ejected from the ſtomach, which at length ſmell of excrement, and

and at laſt ſeem to be only a thin mucilaginous or aqueous liquor.

From whence is it poſſible, that this great quantity of fluid for many ſucceſſive days can be ſupplied, after the cells of the body have given up their fluids, but from the atmoſphere? When the cutaneous branch of abſorbents acts with unnatural ſtrength, it is probable the inteſtinal branch has its motions inverted, and thus a fluid is ſupplied without entering the arterial ſyſtem. Could oiling or painting the ſkin give a check to this diſeaſe?

So when the ſtomach has its motions inverted, the lymphatics of the ſtomach, which are moſt ſtrictly aſſociated with it, invert their motions at the ſame time. But the more diſtant branches of lymphatics, which are leſs ſtrictly aſſociated with it, act with increaſed energy; as the cutaneous lymphatics in the cholera, or iliac paſſion, above deſcribed. And other irritative motions become decreaſed, as the pulſations of the arteries, from the extra-derivation or exhauſtion of the ſenſorial power.

Sometimes when ſtronger vomiting takes place, the more diſtant branches of the lymphatic ſyſtem invert their motions with thoſe of the ſtomach, and looſe ſtools are produced, and cold ſweats.

So when the lacteals have their motions inverted, as during the operation of ſtrong purges, the urinary and cutaneous abſorbents have their motions increaſed to ſupply the want of fluid in the blood, as in great thirſt; but after a meal with ſufficient potation the urine is pale, that is, the urinary abſorbents act weakly, no ſupply of water being wanted for the blood. And when the inteſtinal abſorbents act too violently, as when too great quantities of fluid have been drank, the urinary abſorbents invert their motions to carry off the

ſuperfluity

ſuperfluity, which is a new circumſtance of aſſociation, and a temporary diabetes ſupervenes.

16. I have had the oportunity of ſeeing four patients in the iliac paſſion, where the ejected material ſmelled and looked like excrement. Two of theſe were ſo exhauſted at the time I ſaw them, that more blood could not be taken from them, and as their pain had ceaſed, and they continued to vomit up every thing which they drank, I ſuſpected that a mortification of the bowel had already taken place, and as they were both women advanced in life, and a mortification is produced with leſs preceding pain in old and weak people, theſe both died. The other two, who were both young men, had ſtill pain and ſtrength ſufficient for further veneſection, and they neither of them had any appearance of hernia, both recovered by repeated bleeding, and a ſcruple of calomel given to one, and half a dram to the other, in very ſmall pills: the uſual means of clyſters, and purges joined with opiates, had been in vain attempted. I have thought an ounce or two of crude mercury in leſs violent diſeaſes of this kind has been of uſe, by contributing to reſtore its natural motion to ſome part of the inteſtinal canal, either by its weight or ſtimulus; and that hence the whole tube recovered its uſual aſſociations of progreſſive periſtaltic motion. I have in three caſes ſeen crude mercury given in ſmall doſes, as one or two ounces twice a day, have great effect in ſtopping pertinacious vomitings.

17. Beſides the affections above deſcribed, the ſtomach is liable, like many other membranes of the body, to torpor without conſequent inflammation: as happens to the membranes about the hēad in ſome caſes of hemicrania, or in general headach. This torpor of the ſtomach is attended with indigeſtion, and conſequent flatulency, and with pain, which is uſually called the cramp of the ſtomach,

mach, and is relievable by aromatics, eſſential oils, alcohol, or opium.

The intruſion of a gall-ſtone into the common bile-duct from the gall-bladder is ſometimes miſtaken for a pain of the ſtomach, as neither of them are attended with fever; but in the paſſage of a gall-ſtone, the pain is confined to a leſs ſpace, which is exactly where the common bile-duct enters the duodenum, as explained in Section XXX. 3. Whereas in this gaſtrodynia the pain is diffuſed over the whole ſtomach; and, like other diſeaſes from torpor, the pulſe is weaker, and the extremities colder, and the general debility greater, than in the paſſage of a gall ſtone; for in the former the debility is the conſequence of the pain, in the latter it is the cauſe of it.

Though the firſt fits of the gout, I believe, commence with a torpor of the liver; and the ball of the toe becomes inflamed inſtead of the membranes of the liver in conſequence of this torpor, as a coryza or catarrh frequently ſucceeds a long expoſure of the feet to cold, as in ſnow, or on a moiſt brick-floor; yet in old or exhauſted conſtitutions, which have been long habituated to its attacks, it ſometimes commences with a torpor of the ſtomach, and is transferable to every membrance of the body. When the gout begins with torpor of the ſtomach, a painful ſenſation of cold occurs, which the patient compares to ice, with weak pulſe, cold extremities, and ſickneſs; this in its ſlighter degree is relievable by ſpice, wine, or opium; in its greater degree it is ſucceeded by ſudden death, which is owing to the ſympathy of the ſtomach with the heart, as explained below.

If the ſtomach becomes inflamed in conſequence of this gouty torpor of it, or in conſequence of its ſympathy with ſome other part, the danger is leſs. A ſickneſs and vomiting continues many days, or

even

even weeks, the ſtomach rejecting every thing ſtimulant, even opium or alcohol, together with much viſcid mucus; till the inflammation at length ceaſes, as happens when other membranes, as thoſe of the joints, are the ſeat of gouty inflammation; as obſerved in Sect. XXIV. 2. 8.

The ſympathy or aſſociation of motions, between thoſe of the ſtomach and thoſe of the heart, are evinced in many diſeaſes. Firſt, many people are occaſionally affected with an intermiſſion of their pulſe for a few days, which then ceaſes again. In this caſe there is a ſtop of the motion of the heart, and at the ſame time a tendency to eructation from the ſtomach. As ſoon as the patient feels a tendency to the intermiſſion of the motion of his heart, if he voluntarily brings up wind from his ſtomach, the ſtop of the heart does not occur. From hence I conclude that the ſtop of digeſtion is the primary diſeaſe; and that air is inſtantly generated from the aliment, which begins to ferment, if the digeſtive proceſs is impeded for a moment, (ſee Sect. XXIII. 4.); and that the ſtop of the heart is in conſequence of the aſſociation of the motions of theſe viſcera, as explained in Sect. XXXV. 1. 4.; but if the little air, which is inſtantly generated during the temporary torpor of the ſtomach, be evacuated, the digeſtion recommences, and the temporary torpor of the heart does not follow. One patient, whom I lately ſaw, and who had been five or ſix days much troubled with this intermiſſion of a pulſation of his heart, and who had hemicrania with ſome fever, was immediately relieved from them all by loſing ten ounces of blood, which had what is termed an inflammatory cruſt on it.

Another inſtance of this aſſociation between the motions of the ſtomach and heart is evinced by the exhibition of an over doſe of foxglove, which induces an inceſſant vomiting, which is attended with

very ſlow, and ſometimes intermitting pulſe.—Which continues in ſpite of the exhibition of wine and opium for two or three days. To the ſame aſſociation muſt be aſcribed the weak pulſe, which conſtantly attends the exhibition of emetics during their operation. And alſo the ſudden deaths, which have been occaſioned in boxing by a blow on the ſtomach; and laſtly, the ſudden death of thoſe, who have been long debilitated by the gout, from the torpor of the ſtomach. See Sect. XXV. 1. 4.

SECT.

SECT. XXVI.

OF THE CAPILLARY GLANDS AND MEMBRANES.

I. 1. *The capillary veſſels are glands.* 2. *Their excretory ducts. Experiments on the mucus of the inteſtines, abdomen, cellular membrane, and on the humours of the eye.* 3. *Scurf on the head, cough, catarrh, diarrhœa, gonorrhœa.* 4. *Rheumatiſm. Gout. Leproſy.* II. 1. *The moſt minute membranes are unorganized.* 2. *Larger membranes are compoſed of the ducts of the capillaries, and the mouths of the abſorbents.* 3. *Mucilaginous fluid is ſecreted on their ſurfaces.* III. *Three kinds of Rheumatiſm.*

I. 1. THE capillary veſſels are like all the other glands except the abſorbent ſyſtem, inaſmuch as they receive blood from the arteries, ſeparate a fluid from it, and return the remainder by the veins.

2. This ſeries of glands is of the moſt extenſive uſe, as their excretory ducts open on the whole external ſkin forming its perſpirative pores, and on the internal ſurfaces of every cavity of the body. Their ſecretion on the ſkin is termed inſenſible perſpiration, which in health is in part reabſorbed by the mouths of the lymphatics, and in part evaporated in the air; the ſecretion on the membranes, which line the larger cavities of the body, which have external openings, as the mouth and inteſtinal canal, is termed mucus, but is not however coagulable by heat; and the ſecretion of the membranes of thoſe cavities of the body, which have no external openings, is called lymph or water, as in the cavities of the cellular membrane, and of the abdomen; this lymph however is coagulable by the heat of boiling water. Some mucus nearly as viſcid as

the white of egg, which was diſcharged by ſtool, did not coagulate, though I evaporated it to one-fourth of the quantity, nor did the aqueous and vitreous humours of a ſheep's eye coagulate by the like experiment: but the ſeroſity from an anaſarcous leg, and that from the abdomen of a dropſical perſon, and the cryſtalline humour of a ſheep's eye, coagulated in the ſame heat.

3. When any of theſe capillary glands are ſtimulated into greater irritative actions, than is natural, they ſecrete a more copious material; and as the mouths of the abſorbent ſyſtem, which open in their vicinity, are at the ſame time ſtimulated into greater action, the thinner and more ſaline part of the ſecreted fluid is taken up again; and the remainder is not only more copious but alſo more viſcid than natural. This is more or leſs troubleſome or noxious according to the importance of the functions of the part affected: on the ſkin and bronchiæ, where this ſecretion ought naturally to evaporate, it becomes ſo viſcid as to adhere to the membrane; on the tongue it forms a pellicle, which can with difficulty be ſcraped off; produces the ſcurf on the heads of many people; and the mucus, which is ſpit up by others in coughing. On the noſtrils and fauces, when the ſecretion of theſe capillary glands is increaſed, it is termed ſimple catarrh; when in the inteſtines, a mucous diarrhœa; and in the urethra, or vagina, it has the name of gonorrhœa, or fluor albus.

4. When theſe capillary glands become inflamed, a ſtill more viſcid or even cretaceous humour is produced upon the ſurfaces of the membranes, which is the cauſe or the effect of rheumatiſm, gout, leproſy, and of hard tumours of the legs, which generally termed ſcorbutic; all which will be treated of hereafter.

II. 1. The

II. 1. The whole ſurface of the body, with all its cavities and contents, are covered with membrane. It lines every veſſel, forms every cell, and binds together all the muſcular and perhaps the oſſeous fibres of the body; and is itſelf therefore probably a ſimpler ſubſtance than thoſe fibres. And as the containing veſſels of the body from the largeſt to the leaſt are thus lined and connected with membranes, it follows that theſe membranes themſelves conſiſted of unorganized materials.

For however ſmall we may conceive the diameters of the minuteſt veſſels of the body, which eſcape our eyes and glaſſes, yet theſe veſſels muſt conſiſt of coats or ſides, which are made up of an unorganized material, and which are probably produced from a gluten, which hardens after its production, like the ſilk or web of caterpillars and ſpiders. Of this material conſiſt the membranes, which line the ſhells of eggs, and the ſhell itſelf, both which are unorganized, and are formed from mucus, which hardens after it is formed, either by the abſorption of its more fluid part, or by its uniting with ſome part of the atmoſphere. Such is alſo the production of the ſhells of ſnails, and of ſhell-fiſh, and I ſuppoſe of the enamel of the teeth.

2. But though the membranes, that compoſe the ſides of the moſt minute veſſels, are in truth unorganized materials, yet the larger membranes, which are perceptible to the eye, ſeem to be compoſed of an intertexture of the mouths of the abſorbent ſyſtem, and of the excretory ducts of the capillaries, with their concomitant arteries, veins, and nerves: and from this conſtruction it is evident, that theſe membranes muſt poſſeſs great irritability to peculiar ſtimuli, though they are incapable of any motions, that are viſible to the naked eye: and daily experience ſhews us, that in their inflamed

med ſtate they have the greateſt ſenſibility to pain, as in the pleuriſy and paronychia.

3. On all theſe membranes a mucilaginous or aqueous fluid is ſecreted, which moiſtens and lubricates their ſurfaces, as was explained in Section XXIII. 2. Some have doubted, whether this mucus is ſeparated from the blood by an appropriated ſet of glands, or exudes through the membranes, or is an abraſion or deſtruction of the ſurface of the membrane itſelf, which is continually repaired on the other ſide of it, but the great analogy between the capillary veſſels, and the other glands, countenances the former opinion; and evinces, that theſe capillaries are the glands, that ſecrete it; to which we muſt add, that the blood in paſſing theſe capillary veſſels undergoes a change in its colour from florid to purple, and gives out a quantity of heat; from whence, as in other glands, we muſt conclude that ſomething is ſecreted from it.

III. The ſeat of rheumatiſm is in the membranes, or upon them; but there are three very diſtinct diſeaſes, which commonly are confounded under this name. Firſt, when a membrane becomes affected with torpor, or inactivity of the veſſels which compoſe it, pain and coldneſs ſucceed, as in the hemicrania, and other head-achs, which are generally termed nervous rheumatiſm; they exiſt whether the part be at reſt or in motion, and are generally attended with other marks of debility.

Another rheumatiſm is ſaid to exiſt, when inflammation and ſwelling, as well as pain, affect ſome of the membranes of the joints, as of the ancles, wriſts, knees, elbows, and ſometimes of the ribs. This is accompanied with fever, is analogous to pleuriſy and other inflammations, and is termed the acute rheumatiſm.

A third diſeaſe is called chronic rheumatiſm, which is diſtinguiſhed from that firſt mentioned, as

in

in this the pain only affects the patient during the motion of the part, and from the second kind of rheumatism above described, as it is not attended with quick pulse or inflammation. It is generally believed to succeed the acute rheumatism of the same part, and that some coagulable lymph, or cretaceous, or calculous material, has been left on the membrane; which gives pain, when the muscles move over it, as some extraneous body would do, which was too insoluble to be absorbed. Hence there is an analogy between the chronic rheumatism and the diseases which produce gravel or gout-stones; and it may perhaps receive relief from the same remedies, such as aerated sal soda.

SECT.

SECT. XXVII.

OF HÆMORRHAGES.

I. The veins are abſorbent veſſels. 1. Hæmorrhages from inflammation. Caſe of hæmorrhage from the kidney cured by cold bathing. Caſe of hæmorrhage from the noſe cured by cold immerſion. II. Hæmorrhage from venous paralyſis. Of Piles. Black ſtools. Petechiæ. Conſumption. Scurvy of the lungs. Blackneſs of the face and eyes in epileptic fits. Cure of hæmorrhages from venous inability.

I. AS the imbibing mouths of the abſorbent ſyſtem already deſcribed open on the ſurface, and into the larger cavities of the body, ſo there is another ſyſtem of abſorbent veſſels, which are not commonly eſteemed ſuch, I mean the veins, which take up the blood from the various glands and capillaries, after their proper fluids or ſecretions have been ſeparated from it.

The veins reſemble the other abſorbent veſſels; as the progreſſion of their contents is carried on in the ſame manner in both, they alike abſorb their appropriated fluids, and have valves to prevent its regurgitation by the accidents of mechanical violence. This appears firſt, beccauſe there is no pulſation in the very beginnings of the veins, as is ſeen by microſcopes; which muſt happen, if the blood was carried into them by the actions of the arteries. For though the concurrence of various venous ſtreams of blood from different diſtances muſt prevent any pulſation in the larger branches, yet in the very beginnings of all theſe branches a pulſation muſt

muſt unavoidably exiſt, if the circulation in them was owing to the intermitted force of the arteries. Secondly, the venous abſorption of blood from the penis, and from the teats of female animals after their erection, is ſtill more ſimilar to the lymphatic abſorption, as it is previouſly poured into cells, where all arterial impulſe muſt ceaſe.

There is an experiment, which ſeems to evince this venous abſorption, which conſiſts in the external application of a ſtimulus to the lips, as of vinegar, by which they become inſtantly pale, that is, the bibulous mouths of the veins by this ſtimulus are excited to abſorb the blood faſter, than it can be ſupplied by the uſual arterial exertion. See Sect. XXIII. 5.

There are two kinds of hæmorrhages frequent in diſeaſes, one is where the glandular or capillary action is too powerfully exerted, and propels the blood forwards more haſtily, than the veins can abſorb it; and the other is, where the abſorbent power of the veins is diminiſhed, or a branch of them is become totally paralytic.

The former of theſe caſes is known by the heat of the part, and the general fever or inflammation that accompanies the hæmorrhage. An hæmorrhage from the noſe or from the lungs is ſometimes a criſis of inflammatory diſeaſes, as of the hepatitis and gout, and generally ceaſes ſpontaneouſly, when the veſſels are conſiderably emptied. Sometimes the hæmorrhage recurs by daily periods accompanying the hot fits of fever, and ceaſing in the cold fits, or in the intermiſſions; this is to be cured by removing the febrile paroxyſms, which will by treated of in their place. Otherwiſe it is cured by veneſection, by the internal or external preparations of lead, or by the application of cold, with an abſtemious diet, and diluting liquids, like other inflammations,

ſlammations. Which by inducing a quieſcence on thoſe glandular parts, that are affected, prevents a greater quantity of blood from being protruded forwards, than the veins are capable of abſorbing.

Mr. B——— had an hæmorrhage from his kidney, and parted with not leſs than a pint of blood a day (by conjecture) along with his urine for above a fortnight: veneſections, mucilages, balſams, preparations of lead, the bark, alum, and dragon's blood, opiates, with a large bliſter on his loins, were ſeparately tried, in large doſes, to no purpoſe. He was then directed to bathe in a cold ſpring up to the middle of his body only, the upper part being covered, and the hæmorrhage diminiſhed at the firſt, and ceaſed at the ſecond immerſion.

In this caſe the external capillaries were rendered quieſcent by the coldneſs of the water, and thence a leſs quantity of blood was circulated through them; and the internal capillaries, or other glands, became quieſcent from their irritative aſſociations with the external ones; and the hæmorrhage was ſtopped a ſufficient time for the ruptured veſſels to contract their apertures, or for the blood in thoſe apertures to coagulate.

Mrs. K——— had a continued hæmorrhage from her noſe for ſome days; the ruptured veſſel was not to be reached by plugs up the noſtrils, and the ſenſibility of her fauces was ſuch that nothing could be borne behind the uvula. After repeated veneſection, and other common applications, ſhe was directed to immerſe her whole head into a pail of water, which was made colder by the addition of ſeveral handfuls of ſalt, and the hæmorrhage immediately ceaſed, and returned no more; but her pulſe continued hard, and ſhe was neceſſitated

ted to loſe blood from the arm on the ſucceeding day.

Query, might not the cold bath inſtantly ſtop hæmorrhages from the lungs in inflammatory caſes? —for the ſhortneſs of breath of thoſe who go ſuddenly into cold water, is not owing to the accumulation of blood in the lungs, but to the quieſcence of the pulmonary capillaries from aſſociation, as explained in Section XXXII. 3. 2.

II. The other kind of hæmorrhage is known from its being attended with a weak pulſe, and other ſymptoms of general debility, and very frequently occurs in thoſe, who have diſeaſed livers, owing to intemperance in the uſe of fermented liquors. Theſe conſtitutions are ſhewn to be liable to paralyſis of the lymphatic abſorbents, producing the various kinds of dropſies in Section XXIX. 5. Now if any branch of the venous ſyſtem loſes its power of abſorption, the part ſwells, and at length burſts and diſcharges the blood, which the capillaries or other glands circulate through them.

It ſometimes happens that the large external veins of the legs burſt, and effuſe their blood; but this occurs moſt frequently in the veins of the inteſtines, as the vena portarum is liable to ſuffer from a ſchirrus of the liver oppoſing the progreſſion of the blood, which is abſorbed from the inteſtines. Hence the piles are a ſymptom of hepatic obſtruction, and hence the copious diſcharges downwards or upwards of a black material, which has been called melancholia, or black bile; but is no other than the blood, which is probably diſcharged from the veins of the inteſtines.

J. F. Meckel, in his Experimenta de Finibus Vaſorum, publiſhed at Berlin, 1772, mentions his diſcovery of a communication of a lymphatic veſſel with

with the gaſtric branch of the vena portarum. It is poſſible, that when the motion of the lymphatic becomes retrograde in ſome diſeaſes, that blood may obtain a paſſage into it, where it anaſtomoſes with the vein, and thus be poured into the inteſtines. A diſcharge of blood with the urine ſometimes attends diabetes, and may have its ſource in the ſame manner.

Mr. A———, who had been a hard drinker, and had the gutta roſacea on his face and breaſt, after a ſtroke of the palſy voided near a quart of a black viſcid material by ſtool: on diluting it with water it did not become yellow, as it muſt have done if it had been inſpiſſated bile, but continued black like the grounds of coffee.

But any other part of the venous ſyſtem may become quieſcent or totally paralytic as well as the veins of the inteſtines: all which occur more frequently in thoſe who have diſeaſed livers, than in any others. Hence troubleſome bleedings of the noſe, or from the lungs with a weak pulſe; hence hæmorrhages from the kidneys, too great menſtruation; and hence the oozing of blood from every part of the body, and the petechiæ in thoſe fevers, which are termed putrid, and which is erroneouſly aſcribed to the thinneſs of the blood: for the blood in inflammatory diſeaſes is equally fluid before it coagulates in the cold air.

Is not that hereditary conſumption, which occurs chiefly in dark-eyed people about the age of twenty, and commences with ſlight pulmonary hæmorrhages without fever, a diſeaſe of this kind?—Theſe hæmorrhages frequently begin during ſleep, when the irritability of the lungs is not ſufficient in theſe patients to carry on the circulation without the aſſiſtance of volition; for in our waking hours, the motions of the lungs are in part voluntary, eſpecially

ally if any difficulty of breathing renders the efforts of volition neceſſary. See Claſs I. 2. 1. 3. and Claſs III. 2. 1. 12. Another ſpecies of pulmonary conſumption which ſeems more certainly of ſcrophulous origin is deſcribed in the next Section, No. 2.

I have ſeen two caſes of women, of about forty years of age, both of whom were ſeized with quick weak pulſe, with difficult reſpiration, and who ſpit up by coughing much viſcid mucus mixed with dark coloured blood. They had both large vibices on their limbs, and petechiæ; in one the feet were in danger of mortification, in the other the legs were œdematous. To relieve the difficult reſpiration, about ſix ounces of blood were taken from one of them, which to my ſurpriſe was ſizy, like inflamed blood: they had both palpitations or unequal pulſations of the heart. They continued four or five weeks with pale and bloated countenances, and did not ceaſe ſpitting phlegm mixed with black blood, and the pulſe ſeldom ſlower than 130 or 135 in a minute. This blood, from its dark colour, and from the many vibices and petechiæ, ſeems to have been venous blood; the quickneſs of the pulſe, and the irregularity of the motion of the heart, are to be aſcribed to debility of that part of the ſyſtem; as the extravaſation of blood originated from the defect of venous abſorption. The approximation of theſe two caſes to ſea-ſcurvy is peculiar, and may allow them to be called ſcorbutus pulmonalis. Had theſe been younger ſubjects, and the paralyſis of the veins had only affected the lungs, it is probable the diſeaſe would have been a pulmonary conſumption.

Laſt week I ſaw a gentleman of Birmingham, who had for ten days laboured under great palpitation of his heart, which was ſo diſtinctly felt by the

the hand, as to diſcountenance the idea of there being a fluid in the pericardium. He frequently ſpit up mucus ſtained with dark coloured blood, his pulſe very unequal and very weak, with cold hands and noſe. He could not lie down at all, and for about ten days paſt could not ſleep a minute together, but waked perpetually with great uneaſineſs. Could thoſe ſymptoms be owing to very extenſive adheſions of the lungs? or is this a ſcorbutus pulmonalis? After a few days he ſuddenly got ſo much better as to be able to ſleep many hours at a time by the uſe of one grain of powder of foxglove twice a day, and a grain of opium at night. After a few days longer, the bark was exhibited, and the opium continued with ſome wine; and the palpitations of his heart became much relieved, and he recovered his uſual degree of health, but died ſuddenly ſome months afterwards.

In epileptic fits the patients frequently become black in the face, from the temporary paralyſis of the venous ſyſtem of this part. I have known two inſtances where the blackneſs has continued many days. Mr. P——, who had drank intemperately, was ſeized with the epilepſy when he was in his fortieth year; in one of theſe fits the white part of his eyes was left totally black with effuſed blood; which was attended with no pain or heat, and was in a few weeks gradually abſorbed, changing colour as is uſual with vibices from bruiſes.

The hæmorrhages produced from the inability of the veins to abſorb the refluent blood, is cured by opium, the preparations of ſteel, lead, the bark, vitriolic acid, and bliſters; but theſe have the effect with much more certainty, if a veneſection to a few ounces, and a moderate cathartic with four or ſix grains of calomel be premiſed, where the patient

is

is not already too much debilitated; as one great means of promoting the abſorption of any fluid conſiſts in previouſly emptying the veſſels, which are to receive it.

SECT.

SECT. XXVIII.

OF THE PARALYSIS OF THE ABSORBENT SYSTEM.

I. *Paralyſis of the lacteals, atrophy. Diſtaſte to animal food.* II. *Cauſe of dropſy. Cauſe of herpes. Scrophula. Meſenteric conſumption. Pulmonary conſumption. Why ulcers in the lungs are ſo difficult to heal.*

THE term paralyſis has generally been uſed to expreſs the loſs of voluntary motion, as in the hemiplagia, but may with equal propriety be applied to expreſs the diſobediency of the muſcular fibres to the other kinds of ſtimulus; as to thoſe of irritation or ſenſation.

I. There is a ſpecies of atrophy, which has not been well underſtood; when the abſorbent veſſels of the ſtomach and inteſtines have been long inured to the ſtimulus of too much ſpirituous liquor, they at length, either by the too ſudden omiſſion of fermented or ſpirituous potation, or from the gradual decay of nature, become in a certain degree paralytic; now it is obſerved in the larger muſcles of the body, when one ſide is paralytic, the other is more frequently in motion, owing to the leſs expenditure of ſenſorial power in the paralytic limbs; ſo in this caſe the other part of the abſorbent ſyſtem acts with greater force, or with greater perſeverance, in conſequence of the paralyſis of the lacteals; and the body becomes greatly emaciated in a ſmall time.

I have ſeen ſeveral patients in this diſeaſe, of which the following are the circumſtances. 1. They were men of about fifty years of age, and had lived freely in reſpect to fermented liquors. 2. They loſt

loſt their appetite to animal food. 3. They became ſuddenly emaciated to a great degree. 4. Their ſkins were dry and rough. 5. They coughed and expectorated with difficulty a viſcid phlegm. 6. The membrane of the tongue was dry and red, and liable to become ulcerous.

The inability to digeſt animal food, and the conſequent diſtaſte to it, generally precedes the dropſy, and other diſeaſes, which originate from ſpirituous potation. I ſuppoſe when the ſtomach becomes inirritable, that there is at the ſame time a deficiency of gaſtric acid; hence milk ſeldom agrees with theſe patients, unleſs it be previouſly curdled, as they have not ſufficient gaſtric acid to curdle it; and hence vegetable food, which is itſelf aceſcent, will agree with their ſtomachs longer than animal food, which requires more of the gaſtric acid for its digeſtion.

In this diſeaſe the ſkin is dry from the increaſed abſorption of the cutaneous lymphatics, the fat is abſorbed from the increaſed abſorption of the cellular lymphatics, the mucus of the lungs is too viſcid to be eaſily ſpit up by the increaſed abſorption of the thinner parts of it, the membrana ſneideriana becomes dry, covered with hardened mucus, and at length becomes inflamed and full of apthæ, and either theſe ſloughs, or pulmonary ulcers, terminate the ſcene.

II. The immediate cauſe of dropſy is the paralyſis of ſome other branches of the abſorbent ſyſtem, which are called lymphatics, and which open into the larger cavities of the body, or into the cells of the cellular membrane; whence thoſe cavities or cells become diſtended with the fluid, which is hourly ſecreted into them for the purpoſe of lubricating their ſurfaces. As is more fully explained in No. 5. of the next Section.

As thoſe lymphatic veſſels conſiſt generally of a long neck or mouth, which drinks up its appropriated fluid, and of a conglobate gland, in which this fluid undergoes ſome change, it happens, that ſometimes the mouth of the lymphatic, and ſometimes the belly or glandular part of it, becomes totally or partially paralytic. In the former caſe, where the mouths of the cutaneous lymphatics become torpid or quieſcent, the fluid ſecreted on the ſkin ceaſes to be abſorbed, and erodes the ſkin by its ſaline acrimony, and produces eruptions termed herpes, the diſcharge from which is as ſalt, as the tears, which are ſecreted too faſt to be reabſorbed, as in grief, or when the puncta lacrymalia are obſtructed, and which running down the cheek redden and inflame the ſkin.

When the mouths of the lymphatics, which open on the mucous membrane of the noſtrils, become torpid, as on walking into the air in a froſty morning; the mucus, which continues to be ſecreted, has not its aqueous and ſaline part reabſorbed, which running over the upper lip inflames it, and has a ſalt taſte, if it falls on the tongue.

When the belly, or glandular part of theſe lymphatics, becomes torpid, the fluid abſorbed by its mouth ſtagnates, and forms a tumour in the gland. This diſeaſe is called the ſcrophula. If theſe glands ſuppurate externally, they gradually heal, as thoſe of the neck; if they ſuppurate without an opening on the external habit, as the meſenteric glands, a hectic fever enſues, which deſtroys the patient; if they ſuppurate in the lungs, a pulmonary conſumption enſues, which is believed thus to differ from that deſcribed in the preceding Section, in reſpect to its ſeat or proximate cauſe.

It is remarkable, that matter produced by ſuppuration will lie concealed in the body many weeks, or even months, without producing hectic fever; but

but as ſoon as the wound is opened, ſo as to admit air to the ſurface of the ulcer, a hectic fever ſupervenes, even in very few hours, which is probably owing to the azotic part of the atmoſphere rather than to the oxygene; becauſe thoſe medicines, which contain much oxygene, as the calces or oxydes of metals, externally applied, greatly contribute to heal ulcers, of theſe are the ſolutions of lead and mercury, and copper in acids, or their precipitates.

Hence when wounds are to be healed by the firſt intention, as it is called, it is neceſſary carefully to exclude the air from them. Hence we have one cauſe, which prevents pulmonary ulcers from healing, which is their being perpetually expoſed to the air.

Both the dark-eyed patients, which are affected with pulmonary ulcers from dificient venous abſorption, as deſcribed in Section XXVII. 2. and the light-eyed patients from deficient lymphatic abſorption, which we are now treating of, have generally large apertures of the iris; theſe large pupils of the eyes are a common mark of want of irritability; and it generally happens, that an increaſe of ſenſibility, that is, of motions in conſequence of ſenſation, attends theſe conſtitutions. See Sect. XXXI. 2. Whence inflammations may occur in theſe from ſtagnated fluids more frequently than in thoſe conſtitutions, which poſſeſs more irritability and leſs ſenſibility.

Great expectations in reſpect to the cure of conſumptions, as well as of many other diſeaſes, are produced by the very ingenious exertions of Dr. Beddoes; who has eſtabliſhed an apparatus for breathing various mixtures of airs or gaſſes, at the hot-wells near Briſtol, which well deſerves the attention of the public.

Dr. Beddoes very ingeniouſly concludes, from the florid colour of the blood of conſumptive patients, that it abounds in oxygene; and that the redneſs of their tongues and lips, and the fine bluſh of their cheeks ſhew the preſence of the ſame principle, like fleſh reddened by nitre. And adds, that the circumſtance of the conſumptions of pregnant women being ſtopped in their progreſs during pregnancy, at which time their blood may be ſuppoſed to be in part deprived of its oxygene, by oxygenating the blood of the fœtus, is a forcible argument in favour of this theory; which muſt ſoon be confirmed or confuted by his experiments. See Eſſay on Scurvy, Conſumption, &c. by Dr. Beddoes. Murray. London. Alſo Letter to Dr. Darwin, by the ſame. Murray. London.

SECT.

SECT. XXIX.

ON THE RETROGRADE MOTIONS OF THE ABSORBENT SYSTEM.

I. *Account of the abſorbent ſyſtem.* II. *The valves of the abſorbent veſſels may ſuffer their fluids to regurgitate in ſome diſeaſes.* III. *Communication from the alimentary canal to the bladder by means of the abſorbent veſſels.* IV. *The phænomena of diabetes explained.* V. 1. *The phænomena of dropſies explained.* 2. *Caſes of the uſe of foxglove.* VI. *Of cold ſweats.* VII. *Tranſlations of matter, of chyle, of milk, of urine, operation of purging drugs applied externally.* VIII. *Circumſtances by which the fluids, that are effuſed by the retrograde motions of the abſorbent veſſels, are diſtinguiſhed.* IX. *Retrograde motions of vegetable juices.* X. *Objections anſwered.* XI. *The caſes, which induce the retrograde motions of animal veſſels, and the medicines by which the natural motions are reſtored.*

N. B. The following Section is a tranſlation of a part of a Latin theſis written by the late Mr. Charles Darwin, which was printed with his prize diſſertation on a criterion between matter and mucus in 1780. *Sold by Cadell, London.*

I. *Account of the Abſorbent Syſtem.*

1. THE abſorbent ſyſtem of veſſels in animal bodies conſiſts of ſeveral branches, differing in reſpect to their ſituations, and to the fluids, which they abſorb.

The inteſtinal abſorbents open their mouths on the internal ſurfaces of the inteſtines; their office is

to drink up the chyle and the other fluids from the alimentary canal; and they are termed lacteals, to diſtinguiſh them from the other abſorbent veſſels, which have been termed lympatics.

Thoſe whoſe mouths are diſperſed on the external ſkin, imbibe a great quantity of water from the atmoſphere, and a part of the perſpirable matter, which does not evaporate, and are termed cutaneous abſorbents.

Thoſe, which ariſe from the internal ſurface of the bronchia, and which imbibe moiſture from the atmoſphere, and a part of the bronchial mucus, are called pulmonary abſorbents.

Thoſe, which open their innumerable mouths into the cells of the whole cellular membrane; and whoſe uſe is to take up the fluid, which is poured into thoſe cells, after it has done its office there; may be called cellular abſorbents.

Thoſe, which ariſe from the internal ſurfaces of the membranes, which line the larger cavities of the body, as the thorax, abdomen, ſcrotum, pericardium, take up the mucus poured into thoſe cavities; and are diſtinguiſhed by the names of their reſpective cavities.

Whilſt thoſe, which ariſe from the internal ſurfaces of the urinary bladder, gall-bladder, ſalivary ducts, or other receptacles of ſecreted fluids, may take their names from thoſe fluids; the thinner parts of which it is their office to abſorb: as urinary, bilious, or ſalivary abſorbents.

2. Many of theſe abſorbent veſſels, both lacteals and lymphatics, like ſome of the veins, are replete with valves: which ſeem deſigned to aſſiſt the progreſs of their fluids, or at leaſt to prevent their regurgitation; where they are ſubjected to the intermitted preſſure of the muſcular, or arterial actions in their neighbourhood.

Theſe

These valves do not however appear to be necessary to all the absorbents, any more than to all the veins; since they are not found to exist in the absorbent system of fish; according to the discoveries of the ingenious, and much lamented Mr. Hewson. Philos. Trans. v. 59, Enquiries into the Lymph. Syst. p. 94.

3. These absorbent vessels are also furnished with glands, which are called conglobate glands; whose use is not at present sufficiently investigated; but it is probable that they resemble the conglomerate glands both in structure and in use, except that their absorbent mouths are for the conveniency of situation placed at a greater distance from the body of the gland. The conglomerate glands open their mouths immediately into the sanguiferous vessels, which bring the blood, from whence they absorb their respective fluids, quite up to the gland: but these conglobate glands collect their adapted fluids from very distant membranes, or cysts, by means of mouths furnished with long necks for this purpose; and which are called lacteals, or lymphatics.

4. The fluids, thus collected from various parts of the body, pass by means of the thoracic duct into the left subclavian near the jugular vein; except indeed that those collected from the right side of the head and neck, and from the right arm, are carried into the right subclavian vein: and sometimes even the lymphatics from the right side of the lungs are inserted into the right subclavian vein; whilst those of the left side of the head open but just into the summit of the thoracic duct.

5. In the absorbent system there are many anastomoses of the vessels, which seem of great consequence to the preservation of health. These anastomoses are discovered by dissection to be very frequent between the intestinal and urinary lympha-

tics

tics, as mentioned by Mr. Hewſon, (Phil. Tranſ. v. 58.)

6. Nor do all the inteſtinal abſorbents ſeem to terminate in the thoracic duct, as appears from ſome curious experiments of D. Munro, who gave madder to ſome animals, having previouſly put a ligature on the thoracic duct, and found their bones, and the ſerum of their blood, coloured red.

II. *The Valves of the Abſorbent Syſtem may ſuffer their Fluids to regurgitate in ſome Diſeaſes.*

1. The many valves, which occur in the progreſs of the lymphatic and lacteal veſſels, would ſeem inſuperable obſtacles to the regurgitation of their contents. But as theſe valves are placed in veſſels, which are indued with life, and are themſelves indued with life alſo; and are very irritable into thoſe natural motions, which abſorb, or propel the fluids they contain; it is poſſible, in ſome diſeaſes, where theſe valves or veſſels are ſtimulated into unnatural exertions, or are become paralytic, that during the diaſtole of the part of the veſſel to which the valve is attached, the valve may not ſo completely cloſe, as to prevent the relapſe of the lymph or chyle. This is rendered more probable, by the experiments of injecting mercury, or water, or ſuet, or by blowing air down theſe veſſels: all which paſs the valves very eaſily, contrary to the natural courſe of their fluids, when the veſſels are thus a little forcibly dilated, as mentioned by Dr. Haller, Elem. Phyſiol. t. iii. ſ. 4.

"The valves of the thoracic duct are few, ſome aſſert they are not more than twelve, and that they do not very accurately perform their office, as they do not cloſe the whole area of the duct, and thence may permit chyle to repaſs them downwards. In living animals, however, though not always, yet more

more frequently than in the dead, they prevent the chyle from returning. The principal of theſe valves is that, which preſides over the inſertion of the thoracic duct, into the ſubclavian vein; many have believed this alſo to perform the office of a valve, both to admit the chyle into the vein, and to preclude the blood from entering the duct; but in my opinion it is ſcarcely ſufficient for this purpoſe." Haller, Elem. Phyſ. t. vii. p. 226.

2. The mouths of the lymphatics ſeem to admit water to paſs through them after death, the inverted way, eaſier than the natural one; ſince an inverted bladder readily lets out the water with which it is filled; whence it may be inferred, that there is no obſtacle at the mouths of theſe veſſels to prevent the regurgitation of their contained fluids.

I was induced to repeat this experiment, and having accurately tied the ureters and neck of a freſh ox's bladder, I made an opening at the fundus of it; and then, having turned it inſide outwards, filled it half full with water, and was ſurpriſed to ſee it empty itſelf ſo haſtily. I thought the experiment more appoſite to my purpoſe by ſuſpending the bladder with its neck downwards, as the lymphatics are chiefly ſpread upon this part of it, as ſhewn by Dr. Watſon, Philoſ. Tranſ. v. 59. p. 392.

3. In ſome diſeaſes, as in the diabetes and ſcrophula, it is probable the valves themſelves are diſeaſed, and are thence incapable of preventing the return of the fluids they ſhould ſupport. Thus the valves of the aorta itſelf have frequently been found ſchirrous, according to the diſſections of Monſ. Lieutaud, and have given riſe to an interrupted pulſe, and laborious palpitations, by ſuffering a return of part of the blood into the heart. Nor are any parts of the body ſo liable to ſchirroſity as the lymphatic glands and veſſels, inſomuch that

that their ſchirroſities have acquired a diſtinct name, and been termed ſcrophula.

4. There are valves in other parts of the body, analogous to thoſe of the abſorbent ſyſtem, and which are liable, when diſeaſed, to regurgitate their contents: thus the upper and lower orifices of the ſtomach are cloſed by valves, which, when too great quantities of warm water have been drank with a deſign to promote vomiting, have ſometimes reſiſted the utmoſt efforts of the abdominal muſcles, and diaphragm: yet, at other times, the upper valve, or cardia, eaſily permits the evacuation of the contents of the ſtomach; whilſt the inferior valve, or pylorus, permits the bile, and other contents of the duodenum, to regurgitate into the ſtomach.

5. The valve of the colon is well adapted to prevent the retrograde motion of the excrements; yet, as this valve is poſſeſſed of a living power, in the iliac paſſion, either from ſpaſm, or other unnatural exertions, it keeps itſelf open, and either ſuffers or promotes the retrograde movements of the contents of the inteſtines below; as in ruminating animals the mouth of the firſt ſtomach ſeems to be ſo conſtructed, as to facilitate or aſſiſt the regurgitation of the food; the rings of the œſophagus afterwards contracting themſelves in inverted order. De Haen, by means of a ſyringe, forced ſo much water into the rectum inteſtinum of a dog, that he vomited it in a full ſtream from his mouth; and in the iliac paſſion above mentioned, excrements and clyſter are often evacuated by the mouth. See Section XXV. 15.

6. The puncta lacrymalia, with the lacrymal ſack and naſal duct, compoſe a complete gland, and much reſemble the inteſtinal canal: the puncta lacrymalia are abſorbent mouths, that take up the tears from the eye, when they have done their office there, and convey them into the noſtrils; but when the

the naſal duct is obſtructed, and the lacrymal ſack diſtended with its fluid, on preſſure with the finger the mouths of this gland (puncta lacrymalia) will readily diſgorge the fluid, they had previouſly abſorbed, back into the eye.

7. As the capillary veſſels receive blood from the arteries, and ſeparating the mucus, or perſpirable matter from it, convey the remainder back by the veins; theſe capillary veſſels are a ſet of glands, in every reſpect ſimilar to the ſecretory veſſels of the liver, or other large congeries of glands. The beginnings of theſe capillary veſſels have frequent anaſtomoſes into each other, in which circumſtance they are reſembled by the lacteals; and like the mouths or beginnings of other glands, they are a ſet of abſorbent veſſels, which drink up the blood which is brought to them by the arteries, as the chyle is drunk up by the lacteals: for the circulation of the blood through the capillaries is proved to be independent of arterial impulſe; ſince in the bluſh of ſhame, and in partial inflammations, their action is increaſed, without any increaſe of the motion of the heart.

8. Yet not only the mouths, or beginnings of theſe anaſtomoſing capillaries are frequently ſeen by microſcopes, to regurgitate ſome particles of blood, during the ſtruggles of the animal; but retrograde motion of the blood, in the veins of thoſe animals, from the very heart of the extremity of the limbs, is obſervable, by intervals, during the diſtreſſes of the dying creature. Haller, Elem. Phyſiol. t. i. p. 216. Now, as the veins have perhaps all of them a valve ſomewhere between their extremities and the heart, here is ocular demonſtration of the fluids in this diſeaſed condition of the animal, repaſſing through venous valves: and it is hence highly probable, from the ſtricteſt analogy, that if the courſe of the fluids, in the lymphatic veſſels, could

could be ſubjected to microſcopic obſervation, they would alſo, in the diſeaſed ſtate of the animal, be ſeen to repaſs the valves, and the mouths of thoſe veſſels, which had previouſly abſorbed them, or promoted their progreſſion.

III. *Communication from the Alimentary Canal to the Bladder, by means of the Abſorbent Veſſels.*

Many medical philoſophers, both ancient and modern, have ſuſpected that there was a nearer communication between the ſtomach and the urinary bladder, than that of the circulation: they were led into this opinion from the great expedition with which cold water, when drank to exceſs, paſſes off by the bladder; and from the ſimilarity of the urine, when produced in this haſty manner, with the material that was drank.

The former of theſe circumſtances happens perpetually to thoſe who drink abundance of cold water, when they are much heated by exerciſe, and to many at the beginning of intoxication.

Of the latter, many inſtances are recorded by Etmuller, t. xi. p. 716 where ſimple water, wine, and wine with ſugar, and emulſions, were returned by urine unchanged.

There are other experiments, that ſeem to demonſtrate the exiſtence of another paſſage to the bladder, beſides that through the kidneys. Thus Dr. Kratzenſtein put ligatures on the ureters of a dog, and then emptied the bladder by a catheter; yet in a little time the dog drank greedily, and made a quantity of water, (Diſputat. Morbor. Halleri. t. iv. p. 63.) A ſimilar experiment is related in the Philoſophical Tranſactions, with the ſame event, (No. 65, 67, for the year 1670.)

Add to this, that in ſome morbid caſes the urine has continued to paſs, after the ſuppuration or total deſtruction

deſtruction of the kidneys; of which many Inſtances are referred to in the Elem. Phyſiol. t. vii. p. 379. of Dr. Haller.

From all which it muſt be concluded, that ſome fluids have paſſed from the ſtomach or abdomen, without having gone through the ſanguiferous circulation: and as the bladder is ſupplied with many lymphatics, as deſcribed by Dr. Watſon, in the Philoſ. Tranſ. v. 59. p. 392. and as no other veſſels open into it beſides theſe and the ureters, it ſeems evident, that the unnatural urine produced as above deſcribed, when the ureters were tied, or the kidneys obliterated, was carried into the bladder by the retrograde motions of the urinary branch of the lymphatic ſyſtem.

The more certainly to aſcertain the exiſtence of another communication between the ſtomach and bladder, beſides that of the circulation, the following experiment was made, to which I muſt beg your patient attention:—A friend of mine (June 14, 1772) on drinking repeatedly of cold ſmall punch, till he began to be intoxicated, made a quantity of colourleſs urine. He then drank about two drams of nitre diſſolved in ſome of the punch, and eat about twenty ſtalks of boiled aſparagus: on continuing to drink more of the punch, the next urine that he made was quite clear, and without ſmell; but in a little time another quantity was made, which was not quite ſo colourleſs, and had a ſtrong ſmell of the aſparagus: he then loſt about four ounces of blood from the arm.

The ſmell of aſparagus was not at all perceptible in the blood, neither when freſh taken, nor the next morning, as myſelf and two others accurately attended to; yet this ſmell was ſtrongly perceived in the urine, which was made juſt before the blood was taken from his arm.

Some

Some bibulous paper, moiſtened in the ſerum of this blood, and ſuffered to dry, ſhewed no ſigns of nitre by its manner of burning. But ſome of the ſame paper, moiſtened in the urine, and dried, on being ignited, evidently ſhewed the preſence of nitre. This blood and the urine ſtood ſome days expoſed to the ſun in the open air, till they were evaporated to about a fourth of their original quantity, and began to ſtink: the paper which was then moiſtened with the concentrated urine, ſhewed the preſence of much nitre by its manner of burning; whilſt that moiſtened with the blood ſhewed no ſuch appearance at all.

Hence it appears, that certain fluids at the beginning of intoxication, find another paſſage to the bladder beſides the long courſe of the arterial circulation; and as the inteſtinal abſorbents are joined with the urinary lymphatics by frequent anaſtomoſes, as Hewſon has demonſtrated; and as there is no other road, we may juſtly conclude, that theſe fluids paſs into the bladder by the urinary branch of the lymphatics, which has its motions inverted during the diſeaſed ſtate of the animal.

A gentleman, who had been ſome weeks affected with jaundice, and whoſe urine was in conſequence of a very deep yellow, took ſome cold ſmall punch, in which was diſſolved about a dram of nitre; he then took repeated draughts of the punch, and kept himſelf in a cool room, till on the approach of ſlight intoxication he made a large quantity of water; this water had a ſlight yellow tinge, as might be expected from a ſmall admixture of bile ſecreted from the kidneys; but if the whole of it had paſſed through the ſanguiferous veſſels, which were now replete with bile (his whole ſkin being as yellow as gold) would not this urine alſo, as well as that he had made for weeks before, have been of a deep yellow? Paper dipped in this water, and dryed,

dryed, and ignited, ſhewed evident marks of the preſence of nitre, when the flame was blown out.

IV. *The Phænomena of the Diabetes explained, and of ſome Diarrhœas.*

The phænomena of many diſeaſes are only explicable from the retrograde motions of ſome of the branches of the lymphatic ſyſtem; as the great and immediate flow of pale urine in the beginning of drunkenneſs; in hyſteric paroxyſms; from being expoſed to cold air; or to the influence of fear or anxiety.

Before we endeavour to illuſtrate this doctrine, by deſcribing the phænomena of theſe diſeaſes, we muſt premiſe one circumſtance; that all the branches of the lymphatic ſyſtem have a certain ſympathy with each other, inſomuch that when one branch is ſtimulated into unuſual kinds or quantities of motion, ſome other branch has its motions either increaſed, or decreaſed, or inverted at the ſame time. This kind of ſympathy can only be proved by the concurrent teſtimony of numerous facts, which will be related in the courſe of the work. I ſhall only add here, that it is probable, that this ſympathy does not depend on any communication of nervous filaments, but on habit; owing to the various branches of this ſyſtem having frequently been ſtimulated into action at the ſame time.

There are a thouſand inſtances of involuntary motions aſſociated in this manner; as in the act of vomiting, while the motions of the ſtomach and œſophagus are inverted, the pulſations of the arterial ſyſtem by a certain ſympathy become weaker; and when the bowels or kidneys are ſtimulated by poiſon, a ſtone, or inflamation, into more violent action; the ſtomach and œſophagus by ſympathy invert their motions.

1. When

1. When any one drinks a moderate quantity of vinous ſpirit, the whole ſyſtem acts with more energy by conſent with the ſtomach and inteſtines, as is ſeen from the glow on the ſkin, and the increaſe of ſtrength and activity; but when a greater quantity of this inebriating material is drank, at the ſame time that the lacteals are excited into greater action to abſorb it; it frequently happens, that the urinary branch of abſorbents, which is connected with the lacteals by many anaſtomoſes, inverts its motions, and a great quantity of pale unanimalized urine is diſcharged. By this wiſe contrivance too much of an unneceſſary fluid is prevented from entering the circulation—This may be called the drunken diabetes, to diſtinguiſh it from the other temporary diabetes, which occur in hyſteric diſeaſes, and from continued fear or anxiety.

2. If this idle ingurgitation of too much vinous ſpirit be daily practiſed, the urinary branch of abſorbents at length gains an habit of inverting its motions, whenever the lacteals are much ſtimulated; and the whole or a great part of the chyle is thus daily carried to the bladder without entering the circulation, and the body becomes emaciated. This is one kind of chronic diabetes, and may be diſtinguiſhed from the others by the taſte and appearance of the urine; which is ſweet, and the colour of whey, and may be termed the chyliferous diabetes.

3 Many children have a ſimilar diſpoſition of chyle in their urine, from the irritation of worms in their inteſtines, which ſtimulating the mouths of the lacteals into unnatural action, the urinary branch of the abſorbents becomes inverted, and carries part of the chyle to the bladder: part of the chyle alſo has been carried to the iliac and lumber glands, of which inſtances are recorded by Haller, t. vii. 225. and which can be explained on no other theory:

theory: but the diſſections of the lymphatic ſyſtem of the human body, which have yet been publiſhed, are not ſufficiently extenſive for our purpoſe; yet if we may reaſon from comparative anatomy, this tranſlation of chyle to the bladder is much illuſtrated by the account given of this ſyſtem of veſſels in a turtle, by Mr. Hewſon, who obſerved, "That the lacteals near the root of the meſentery anaſtomoſe, ſo as to form a net-work, from which ſeveral large branches go into ſome conſiderable lymphatics lying near the ſpine; and which can be traced almoſt to the anus, and particularly to the kidneys. Philoſ. Tranſ. v. 59. p. 199—Enquiries, p. 74.

4. At the ſame time that the urinary branch of abſorbents, in the beginning of diabetes, is excited into inverted action, the cellular branch is excited by the ſympathy above mentioned, into more energetic action; and the fat, that was before depoſited, is reabſorbed and thrown into the blood veſſels; where it floats, and was miſtaken for chyle, till the late experiments of the ingenious Mr. Hewſon demonſtrated it to be fat.

This appearance of what was miſtaken for chyle in the blood, which was drawn from theſe patients, and the obſtructed liver, which very frequently accompanies this diſeaſe, ſeems to have led Dr. Mead to ſuſpect the diabetes was owing to a defect of ſanguification; and that the ſchirroſity of the liver was the original cauſe of it; but as the ſchirrhus of the liver is moſt frequently owing to the ſame cauſes, that produce the diabetes and dropſies; namely, the great uſe of fermented liquors; there is no wonder they ſhould exiſt together, without being the conſequence of each other.

5. If the cutaneous branch of abſorbents gains a habit of being excited into ſtronger action, and imbibes greater quantities of moiſture from the

atmoſphere, at the ſame time that the urinary branch has its motions inverted, another kind of diabetes is formed, which may be termed the aqueous diabetes. In this diabetes the cutaneous abſorbents frequently imbibe an amazing quantity of atmoſpheric moiſture, inſomuch that there are authentic hiſtories, where many gallons a day, for many weeks together, above the quantity that has been drank, have been diſcharged by urine.

Dr. Keil, in his Medicina Statica, found that he gained eighteen ounces from the moiſt air of one night; and Dr. Percival affirms, that one of his hands imbibed, after being well chafed, near an ounce and half of water, in a quarter of an hour. (Tranſact. of the College, London, vol. ii. p. 102.) Home's Medic. Facts, p. 2. ſect. 3.

The pale urine in hyſterical women, or which is produced by fear or anxiety, is a temporary complaint of this kind; and it would in reality be the ſame diſeaſe, if it was confirmed by habit.

6. The purging ſtools, and pale urine, occaſioned by expoſing the naked body to cold air, or ſprinkling it with cold water, originate from a ſimilar cauſe; for the mouths of the cutaneous lymphatics being ſuddenly expoſed to cold become torpid, and ceaſe, or nearly ceaſe, to act; whilſt, by the ſympathy above deſcribed, not only the lymphatics of the bladder and inteſtines ceaſe alſo to abſorb the more aqueous and ſaline part of the fluids ſecreted into them; but it is probable that theſe lymphatics invert their motions, and return the fluids, which were previouſly abſorbed, into the inteſtines and bladder. At the very inſtant that the body is expoſed naked to the cold air, an unuſual movement is felt in the bowels; as is experienced by boys going into the cold bath: this could not occur from an obſtruction of the perſpirable matter, ſince there

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is not time for that to be returned to the bowels by the courſe of the circulation.

There is alſo a chronic aqueous diarrhœa, in which the atmoſpheric moiſture, drank up by the cutaneous and pulmonary lymphatics, is poured into the inteſtines, by the retrograde motions of the lacteals. This diſeaſe is moſt ſimilar to the aqueous diabetes, and is frequently exchanged for it: a diſtinct inſtance of this is recorded by Benningerus, Cent. v. Obſ. 98. in which an aqueous diarrhœa ſucceeded an aqueous diabetes and deſtroyed the patient. There is a curious example of this, deſcribed by Sympſon (De Re Medica)—"A young man (ſays he) was ſeized with a fever, upon which a diarrhœa came on, with great ſtupor; and he refuſed to drink any thing, though he was parched up with exceſſive heat: the better to ſupply him with moiſture, I directed his feet to be immerſed in cold water; immediately I obſerved a wonderful decreaſe of water in the veſſel, and then an impetuous ſtream of a fluid, ſcarcely coloured, was diſcharged by ſtool, like a cataract."

7. There is another kind of diarrhœa, which has been called cæliaca; in this diſeaſe the chyle, drank up by the lacteals of the ſmall inteſtines, is probably poured into the large inteſtines, by the retrograde motions of their lacteals: as in the chyliferous diabetes, the chyle is poured into the bladder, by the retrograde motions of the urinary branch of abſorbents.

The chyliferous diabetes, like this chyliferous diarrhœa, produces ſudden atrophy; ſince the nouriſhment, which ought to ſupply the hourly waſte of the body, is expelled by the bladder, or rectum: whilſt the aqueous diabetes, and the aqueous diarrhœa produce exceſſive thirſt; becauſe the moiſture, which is obtained from the atmoſphere, is not conveyed to the thoracic receptacle, as it ought to be,

but to the bladder, or lower inteſtines; whence the chyle, blood, and whole ſyſtem of glands, are robbed of their proportion of humidity.

8. There is a third ſpecies of diabetes, in which the urine is mucilaginous, and appears ropy in pouring it from one veſſel into another; and will ſometimes coagulate over the fire. This diſeaſe appears by intervals, and ceaſes again, and ſeems to be occaſioned by a previous dropſy in ſome part of the body. When ſuch a collection is reabſorbed, it is not always returned into the circulation; but the ſame irritation that ſtimulates one lymphatic branch to reabſorb the depoſited fluid, inverts the urinary branch, and pours it into the bladder. Hence this mucilaginous diabetes is a cure, or the conſequence of a cure, of a worſe diſeaſe, rather than a diſeaſe itſelf.

Dr. Cotunnius gave half an ounce of cream of tartar, every morning, to a patient, who had the anaſarca; and he voided a great quantity of urine; a part of which, put over the fire, coagulated, on the evaporation of half of it, ſo as to look like the white of an egg. De Iſchiade Nervos.

This kind of diabetes frequently precedes a dropſy; and has this remarkable circumſtance attending it, that it generally happens in the night; as during the recumbent ſtate of the body, the fluid, that was accumulated in the cellular membrane, or in the lungs, is more readily abſorbed, as it is leſs impeded by its gravity. I have ſeen more than one inſtance of this diſeaſe. Mr. D. a man in the decline of life, who had long accuſtomed himſelf to ſpirituous liquor, had ſwelled legs, and other ſymptoms of approaching anaſarca; about once in a week, or ten days, for ſeveral months, he was ſeized, on going to bed, with great general uneaſineſs, which his attendants reſembled to an hyſteric fit; and which terminated in a great diſcharge of viſcid

viſcid urine; his legs became leſs ſwelled, and he continued in better health for ſome days afterwards. I had not the opportunity to try if this urine would coagulate over the fire, when part of it was evaporated, which I imagine would be the criterion of this kind of diabetes; as the mucilaginous fluid depoſited in the cells and cyſts of the body, which have no communication with the external air, ſeems to acquire, by ſtagnation, this property of coagulation by heat, which the ſecreted mucus of the inteſtines and bladder do not appear to poſſeſs; as I have found by experiment: and if any one ſhould ſuppoſe this coagulable urine was ſeparated from the blood by the kidneys, he may recollect that in the moſt inflammatory diſeaſes, in which the blood is moſt replete or moſt ready to part with the coagulable lymph, none of this appears in the urine.

9. Different kinds of diabetes require different methods of cure. For the firſt kind, or chyliferous diabetes, after clearing the ſtomach and inteſtines, by ipecacuanha and rhubarb, to evacuate any acid material, which may too powerfully ſtimulate the mouths of the lacteals, repeated and large doſes of tincture of cantharides have been much recommended. The ſpecific ſtimulus of this medicine, on the neck of the bladder, is likely to excite the numerous abſorbent veſſels, which are ſpread on that part, into ſtronger natural actions, and by that means prevent their retrograde ones; till, by perſiſting in the uſe of the medicine, their natural habits of motions might again be eſtabliſhed. Another indication of cure, requires ſuch medicines, as by lining the inteſtines with mucilaginous ſubſtances, or with ſuch as conſiſt of ſmooth particles, or which chemically deſtroy the acrimony of their contents, may prevent the too great action of the inteſtinal abſorbents. For this purpoſe, I have found the earth precipitated from a ſolution of alum,

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by means of fixed alcali, given in the doſe of half a dram every ſix hours, of great advantage, with a few grains of rhubarb, ſo as to produce a daily evacuation.

The food ſhould conſiſt of materials that have the leaſt ſtimulus, with calcareous water, as of Briſtol and Matlock; that the mouths of the lacteals may be as little ſtimulated as is neceſſary for their proper abſorption; leſt with their greater exertions, ſhould be connected by ſympathy, the inverted motions of the urinary lymphatics.

The ſame method may be employed with equal advantage in the aqueous diabetes, ſo great is the ſympathy between the ſkin and the ſtomach. To which, however, ſome application to the ſkin might be uſefully added; as rubbing the patient all over with oil, to prevent the too great action of the cutaneous abſorbents. I knew an experiment of this kind made upon one patient with apparent advantage.

The mucilaginous diabetes will require the ſame treatment, which is moſt efficacious in the dropſy, and will be deſcribed below. I muſt add, that the diet and medicines above mentioned, are ſtrongly recommended by various authors, as by Morgan, Willis, Harris, and Etmuller; but more hiſtories of the ſucceſsful treatment of theſe diſeaſes are wanting to fully aſcertain the moſt efficacious methods of cure.

In a letter from Mr. Charles Darwin, dated April 24, 1778, Edinburgh, is the ſubſequent paſſage:—"A man who had long laboured under a diabetes died yeſterday in the clinical ward. He had for ſome time drank four, and paſſed twelve pounds of fluid daily; each pound of urine contained an ounce of ſugar. He took, without conſiderable relief, gum kino, ſanguis draconis melted with alum, tincture of cantharides, iſinglaſs, gum arabic, crabs

eyes

eyes, ſpirit of hartſhorn, and eat ten or fifteen oyſters thrice a day. Dr. Home, having read my theſis, bled him, and found that neither the freſh blood nor the ſerum taſted ſweet. His body was opened this morning—every viſcus appeared in a ſound and natural ſtate, except that the left kidney had a very ſmall pelvis, and that there was a conſiderable enlargement of moſt of the meſenteric lymphatic glands. I intend to inſert this in my theſis, as it coincides with the experiment, where ſome aſparagus was eaten at the beginning of intoxication, and its ſmell perceived in the urine, though not in the blood.'

The following caſe of chyliferous diabetes is extracted from ſome letters of Mr. Hughes, to whoſe unremitted care the infirmary at Stafford for many years was much indebted. Dated October 10, 1778.

Richard Davis, aged 33, a whiteſmith by trade, had drank hard by intervals; was much troubled with ſweating of his hands, which incommoded him in his occupation, but which ceaſed on his frequently dipping them in lime. About ſeven months ago he began to make large quantities of water; his legs are œdematous, his belly tenſe, and he complains of a riſing in his throat, like the globus hyſtericus: he eats twice as much as other people, drinks about fourteen pints of ſmall beer a day, beſides a pint of ale, ſome milk-porridge, and a baſon of broth, and he makes about eighteen pints of water a-day.

He tried alum, dragon's blood, ſteel, blue vitriol, and cantharides in large quantities, and duly repeated, under the care of Dr. Underhill, but without any effect; except that on the day after he omitted the cantharides, he made but twelve pints of water, but on the next day this good effect ceaſed again.

November

November 21.—He made eighteen pints of water, and he now, at Dr. Darwin's requeſt, took a grain of opium every four hours, and five grains of aloes at night; and had a flannel ſhirt given him.

22.—Made ſixteen pints. 23.—Thirteen pints: drinks leſs.

24.—Increaſed the opium to a grain and quarter every four hours: he made twelve pints.

25.—Increaſed the opium to a grain and half: he now makes ten pints; and drinks eight pints in a day.

The opium was gradually increaſed during the next fortnight, till he took three grains every four hours, but without any further diminution of his water. During the uſe of the opium he ſweat much in the nights, ſo as to have large drops ſtand on his face and all over him. The quantity of opium was then gradually decreaſed, but not totally omitted, as he continued to take about a grain morning and evening.

January 17.—He makes fourteen pints of water a day. Dr. Underhill now directed him two ſcruples of common roſin triturated with as much ſugar, every ſix hours; and three grains of opium every night.

19.—Makes fifteen pints of water: ſweats at night.

21.—Makes ſeventeen pints of water; has twitchings of his limbs in a morning, and pains of his legs: he now takes a dram of roſin for a doſe, and continues the opium

23.—Water more coloured, and reduced to ſixteen pints, and he thinks has a brackiſh taſte.

26. Water reduced to fourteen pints.

28.—Water thirteen pints: he continues the opium, and takes four ſcruples of the roſin for a doſe.

February 1.—Water twelve pints.

4.—Water

4.—Water eleven pints: twitchings leſs; takes five ſcruples for a doſe.

8.—Water ten pints: has had many ſtools.

12.—Appetite leſs: purges very much.

After this the roſin either purged him, or would not ſtay on his ſtomach; and he gradually relapſed nearly to his former condition, and in a few months ſunk under the diſeaſe.

October 3, Mr. Hughes evaporated two quarts of the water, and obtained from it four ounces and half of a hard and brittle ſaccharine maſs, like treacle which had been ſome time boiled. Four ounces of blood, which he took from his arm with deſign to examine it, had the common appearances, except that the ſerum reſembled cheeſe-whey; and that on the evidence of four perſons, two of whom did not know what it was they taſted, *the ſerum had a ſaltiſh taſte.*

From hence it appears, that the ſaccharine matter, with which the urine of theſe patients ſo much abounds, does not enter the blood-veſſels like the nitre and aſparagus mentioned above; but that the proceſs of digeſtion reſembles the proceſs of the germination of vegetables, or of making barley into malt; as the vaſt quantity of ſugar found in the urine muſt be made from the food which he took (which was double that taken by others), and from the fourteen pints of ſmall beer which he drank. And, ſecondly, as the ſerum of the blood was not ſweet, the chyle appears to have been conveyed to the bladder without entering the circulation of the blood, ſince ſo large a quantity of ſugar, as was found in the urine, namely, twenty ounces a day, could not have previouſly exiſted in the blood without being perceptible to the taſte.

November 1. Mr. Hughes diſſolved two drams of nitre in a pint of a decoction of the roots of aſparagus, and added to it two ounces of tincture

of

of rhubarb: the patient took a fourth part of this mixture every five minutes, till he had taken the whole. – In about half an hour he made eighteen ounces of water, which was very manifeſtly tinged with the rhubarb; the ſmell of the aſparagus was doubtful.

He then loſt four ounces of blood, the ſerum of which was not ſo opake as that drawn before, but of a yellowiſh caſt, as the ſerum of the blood uſually appears.

Paper, dipped three or four times in the tinged urine and dried again, did not ſcintillate when it was ſet on fire; but when the flame was blown out, the fire ran along the paper for half an inch; which, when the ſame paper was unimpregnated, it would not do; nor when the ſame paper was dipped in urine made before he took the nitre, and dried in the ſame manner.

Paper, dipped in the ſerum of the blood and dried in the ſame manner as in the urine, did not ſcintillate when the flame was blown out, but burnt exactly in the ſame manner as the ſame paper dipped in the ſerum of blood drawn from another perſon.

This experiment, which is copied from a letter of Mr. Hughes, as well as the former, ſeems to evince the exiſtence of another paſſage from the inteſtines to the bladder, in this diſeaſe, beſides that of the ſanguiferous ſyſtem; and coincides with the curious experiment related in ſection the third, except that the ſmell of the aſparagus was not here perceived, owing perhaps to the roots having been made uſe of inſtead of the heads.

The riſing in the throat of this patient, and the twitchings of his limbs, ſeem to indicate ſome ſimilarity between the diabetes and the hyſteric diſeaſe, beſides the great flow of pale urine, which is common to them both.

Perhaps

Perhaps if the meſenteric glands were nicely inſpected in the diſſections of theſe patients; and if the thoracic duct, and the larger branches of the lacteals, and if the lymphatics, which ariſe from the bladder, were well examined by injection, or by the knife, the cauſe of diabetes might be more certainly underſtood.

The opium alone, and the opium with the roſin, ſeem much to have ſerved this patient, and might probably have effected a cure, if the diſeaſe had been ſlighter, or the medicine had been exhibited, before it had been confirmed by habit during the ſeven months it had continued. The increaſe of the quantity of water on beginning the large doſes of roſin was probably owing to his omitting the morning doſes of opium.

V. *The Phænomena of Dropſies explained.*

I. Some inebriates have their paroxyſms of inebriety terminated by much pale urine, or profuſe ſweats, or vomiting, or ſtools; others have their paroxyſms terminated by ſtupor, or ſleep, without the above evacuations.

The former kind of theſe inebriates have been obſerved to be more liable to diabetes and dropſy; and the latter to gout, gravel, and leproſy. Evoe! attend ye bacchanalians! ſtart at this dark train of evils, and, amid your immodeſt jeſts, and idiot laughter, recollect,

Quem Deus vult perdere, prius dementat.

In thoſe who are ſubject to diabetes and dropſy, the abſorbent veſſels are naturally more irritable than in the latter; and by being frequently diſturbed

ed or inverted by violent ſtimulus, and by their too great ſympathy with each other, they become at length either entirely paralytic, or are only ſuſceptible of motion from the ſtimulus of very acrid materials; as every part of the body, after having been uſed to great irritations, becomes leſs affected by ſmaller ones. Thus we cannot diſtinguiſh objects in the night, for ſome time after we come out of a ſtrong light, though the iris is preſently dilated; and the air of a ſummer evening appears cold, after we have been expoſed to the heat of the day.

There are no cells in the body, where dropſy may not be produced, if the lymphatics ceaſe to abſorb that mucilaginous fluid, which is perpetually depoſited in them, for the purpoſe of lubricating their ſurfaces.

If the lymphatic branch, which opens into the cellular membrane, either does its office imperfectly, or not at all; theſe cells become replete with a mucilaginous fluid, which, after it has ſtagnated ſome time in the cells, will coagulate over the fire; and is erroneouſly called water. Wherever the ſeat of this diſeaſe is, (unleſs in the lungs or other pendent viſcera) the mucilaginous liquid above mentioned will ſubſide to the moſt depending parts of the body, as the feet and legs, when thoſe are lower than the head and trunk; for all theſe cells have communications with each other.

When the cellular abſorbents are become inſenble to their uſual irritations, it moſt frequently happens, but not always, that the cutaneous branch of abſorbents, which is ſtrictly aſſociated with them, ſuffers the like inability. And then, as no water is abſorbed from the atmoſphere, the urine is not only leſs diluted at the time of its ſecretion, and conſequently in leſs quantity and higher coloured:

but

but great thirſt is at the ſame time induced, for as no water is abſorbed from the atmoſphere to dilute the chyle and blood, the lacteals and other abſorbent veſſels, which have not loſt their powers, are excited into more conſtant or more violent action, to ſupply this deficiency; whence the urine becomes ſtill leſs in quantity, and of a deeper colour, and turbid like the yolk of an egg, owing to a greater abſorption of its thinner parts. From this ſtronger action of thoſe abſorbents, which ſtill retain their irritability, the fat is alſo abſorbed, and the whole body becomes emaciated. This increaſed exertion of ſome branches of the lymphatics, while others are totally or partially paralytic, is reſembled by what conſtantly occurs in the hemiplagia; when the patient has loſt the uſe of the limbs on one ſide, he is inceſſantly moving thoſe of the other; for the moving power, not having acceſs to the paralytic limbs, becomes redundant in thoſe which are not diſeaſed.

The paucity of urine and thirſt cannot be explained from a greater quantity of mucilaginous fluid being depoſited in the cellular membrane: for though theſe ſymptoms have continued many weeks, or even months, this collection frequently does not amount to more than very few pints. Hence alſo the difficulty of promoting copious ſweats in anaſarca is accounted for, as well as the great thirſt, paucity of urine, and loſs of fat; ſince, when the cutaneous branch of abſorbents is paralytic, or nearly ſo, there is already too ſmall a quantity of aqueous fluid in the blood: nor can theſe torpid cutaneous lymphatics be readily excited into retrograde motions.

Hence likewiſe we underſtand, why in the aſcites, and ſome other dropſies, there is often no thirſt, and no paucity of urine; in theſe caſes the

the cutaneous abſorbents continue to do their office.

Some have believed, that dropſies were occaſioned by the inability of the kidneys, from having only obſerved the paucity of urine; and have thence laboured much to obtain diuretic medicines; but it is daily obſervable, that thoſe who die of a total inability to make water, do not become dropſical in conſe uence of it: Fernelius mentions one, who laboured under a perfect ſuppreſſion of urine during twenty days before his death, and yet had no ſymptoms of dropſy. Pathol. l. vi. c. 8. From the ſame idea many phyſicians have reſtrained their patients from drinking, though their thirſt has been very urgent; and ſome caſes have been publiſhed, where this cruel regimen has been thought advantageous: but others of nicer obſervation are of opinion, that it has always aggravated the diſtreſſes of the patient; and though it has abated his ſwellings, yet by inducing a fever it has haſtened his diſſolution. See Tranſactions of the College, London, vol. ii. p. 235. Caſes of Dropſy by Dr. G. Baker.

The cure of anaſarca, ſo far as reſpects the evacuation of the accumulated fluid, coincides with the idea of the retrograde action of the lymphatic ſyſtem. It is well known that vomits, and other drugs, which induce ſickneſs or nauſea; at the ſame time that they evacuate the ſtomach, produce a great abſorption of the lymph accumulated in the cellular membrane. In the operation of a vomit, not only the motions of the ſtomach and duodenum become inverted, but alſo thoſe of the lymphatics and lacteals, which belong to them; whence a great quantity of chyle and lymph is perpetually poured into the ſtomach and inteſtines, during the operation, and evacuated by the mouth. Now at the

ſame

ſame time, other branches of the lymphatic ſyſtem, viz. thoſe which open on the cellular membrane, are brought into more energetic action, by the ſympathy above mentioned, and an increaſe of their abſorption is produced.

Hence repeated vomits, and cupreous ſalts, and ſmall doſes of ſquill or foxglove, are ſo efficacious in this diſeaſe. And as draſtic purges act alſo by inverting the motions of the lacteals; and thence the other branches of lymphatics are induced into more powerful natural action, by ſympathy, and drink up the fluids from all the cells of the body; and by their anaſtomoſes, pour them into the lacteal branches; which, by their inverted actions, return them into the inteſtines; and they are thus evacuated from the body:—theſe purges alſo are uſed with ſucceſs in diſcharging the accumulated fluid in anaſarca.

II. The following caſes are related with deſign to aſcertain the particular kinds of dropſy in which the digitalis purpurea, or common foxglove, is preferable to ſquill, or other evacuants, and were firſt publiſhed in 1780, in a pamphlet entitled Experiments on mucilaginous and purulent Matter, &c. Cadell. London. Other caſes of dropſy, treated with digitalis, were afterwards publiſhed by Dr. Darwin in the Medical Tranſactions, vol. iii. in which there is a miſtake in reſpect to the doſe of the powder of foxglove, which ſhould have been from five grains to one, inſtead of from five grains to ten.

Anaſarca of the Lungs.

1. A lady, between forty and fifty years of age, had been indiſpoſed ſome time, was then ſeized with cough and fever, and afterwards expectorated much

much digeſted mucus. This expectoration ſuddenly ceaſed, and a conſiderable difficulty of breathing ſupervened, with a pulſe very irregular both in velocity and ſtrength; ſhe was much diſtreſſed at firſt lying down, and at firſt riſing; but after a minute or two bore either of thoſe attitudes with eaſe. She had no pain or numbneſs in her arms; ſhe had no hectic fever, nor any cold ſhiverings, and the urine was in due quantity, and of the natural colour.

The difficulty of breathing was twice conſiderably relieved by ſmall doſes of ipecacuanha, which operated upwards and downwards, but recurred in a few days: ſhe was then directed a decoction of foxglove, (digitalis purpurea) prepared by boiling four ounces of the freſh leaves from two pints of water to one pint; to which was added two ounces of vinous ſpirit: ſhe took three large ſpoonfuls of this mixture every two hours, till ſhe had taken it four times; a continued ſickneſs ſupervened, with frequent vomiting, and a copious flow of urine: theſe evacuations continued at intervals for two or three days, and relieved the difficulty of breathing —She had ſome relapſes afterwards, which were again relieved by the repetition of the decoction of foxglove.

2. A gentleman, about ſixty years of age, who had been addicted to an immoderate uſe of fermented liquors, and had been very corpulent, gradually loſt his ſtrength and fleſh, had great difficulty of breathing, with legs ſomewhat ſwelled, and a very irregular pulſe. He was very much diſtreſſed at firſt lying down, and at firſt riſing from his bed, yet in a minute or two was eaſy in both thoſe attitudes. He made ſtraw-coloured urine in due quantity, and had no pain or numbneſs of his arms.

He

He took a large ſpoonful of the decoction of foxglove, as above, every hour, for ten or twelve ſucceſſive hours, had inceſſant ſickneſs for about two days, and paſſed a large quantity of urine, upon which his breath became quite eaſy, and the ſwelling of his legs ſubſided; but as his whole conſtitution was already ſinking from the previous intemperance of his life, he did not ſurvive more than three or four months.

Hydrops Pericardii.

3. A gentleman of temperate life and ſedulous application to buſineſs, between thirty and forty years of age, had long been ſubject, at interva s, to an irregular pulſe: a few months ago he became weak, with difficulty of breathing, and dry cough. In this ſituation a phyſician of eminence directed him to abſtain from all animal food and fermented liquor, during which regimen all his complaints increaſed; he now became emaciated, and totally loſt his appetite; his pulſe very irregular both in velocity and ſtrength; with great difficulty of breathing, and ſome ſwelling of his legs; yet he could lie down horizontally in his bed, though he got little ſleep, and paſſed a due quantity of urine, and of the natural colour: no fullneſs or hardneſs could be perceived about the region of the liver; and he had no pain or numbneſs in his arms.

One night he had a moſt profuſe ſweat all over his body and limbs, which quite deluged his bed, and for a day or two ſomewhat relieved his difficulty of breathing, and his pulſe became leſs irregular: this copious ſweat recurred three or four times at the intervals of five or ſix days, and repeatedly alleviated his ſymptoms.

He was directed one large ſpoonful of the above decoction of fox-glove every hour, till it procured ſome conſiderable evacuation: after he had taken it eleven ſucceſſive hours he had a few liquid ſtools, attended with a great flow of urine, which laſt had a dark tinge, as if mixed with a few drops of blood: he continued ſick at intervals for two days, but his breath became quite eaſy, and his pulſe quite regular, the ſwelling of his legs diſappeared, and his appetite and ſleep returned.

He then took three grains of white vitriol twice a day, with ſome bitter medicines, and a grain of opium with five grains of rhubarb every night; was adviſed to eat fleſh meat, and ſpice, as his ſtomach would bear it, with ſmall beer, and a few glaſſes of wine; and had iſſues made in his thighs; and has ſuffered no relapſe.

4. A lady, about fifty years of age, had for ſome weeks great difficulty of breathing, with very irregular pulſe, and conſiderable general debility: ſhe could lie down in bed, and the urine was in due quantity and of the natural colour, and ſhe had no pain or numbneſs of her arms.

She took one large ſpoonful of the above decoction of foxglove every hour, for ten or twelve ſucceſſive hours; was ſick, and made a quantity of pale urine for about two days, and was quite relieved both of the difficulty of breathing, and the irregularity of her pulſe. She then took a grain of opium, and five grains of rhubarb, every night, for many weeks; with ſome ſlight chalybeate and bitter medicines, and has ſuffered no relapſe.

Hydrops Thoracis.

5. A tradeſman, about fifty years of age, became weak and ſhort of breath, eſpecially on increaſe of motion,

motion, with pain in one arm, about the inſertion of the biceps muſcle. He obſerved he ſometimes in the night made an unuſual quantity of pale water. He took calomel, alum, and peruvian bark, and all his ſymptoms increaſed: his legs began to ſwell conſiderably; his breath became more difficult, and he could not lie down in bed; but all this time he made a due quantity of ſtraw-coloured water.

The decoction of foxglove was given as in the preceding caſes, which operated chiefly by purging, and ſeemed to relieve his breath for a day or two; but alſo ſeemed to contribute to weaken him.—He became after ſome weeks univerſally dropſical, and died comatous.

6. A young lady of delicate conſtitution, with light eyes and hair, and who had perhaps lived too abſtemiouſly both in reſpect to the quantity and quality of what ſhe eat and drank, was ſeized with great difficulty of breathing, ſo as to threaten immediate death. Her extremities were quite cold, and her breath felt cold to the back of one's hand. She had no ſweat, nor could lie down for a ſingle moment; and had previouſly, and at preſent, complained of great weakneſs and pain and numbneſs of both her arms; had no ſwelling of her legs, no thirſt, water in due quantity and colour. Her ſiſter, about a year before, was afflicted with ſimilar ſymptoms, was repeatedly blooded, and died univerſally dropſical.

A grain of opium was given immediately, and repeated every ſix hours with evident and amazing advantage; afterwards a bliſter, with chalybeates, bitters, and eſſential oils, were exhibited, but nothing had ſuch eminent effect in relieving the difficulty of breathing and coldneſs of her extremities as opium, by the uſe of which in a few weeks

ſhe perfectly regained her health, and has ſuffered no relapſe.

Aſcites.

7. A young lady of delicate conſtitution having been expoſed to great fear, cold, and fatigue, by the overturn of a chaiſe in the night, began with pain and tumour in the right hypochondrium: in a few months a fluctuation was felt throughout the whole abdomen, more diſtinctly perceptible indeed about the region of the ſtomach; ſince the integuments of the lower part of the abdomen generally become thickened in this diſeaſe by a degree of anaſarca. Her legs were not ſwelled, no thirſt, water in due quantity and colour.—She took the foxglove ſo as to induce ſickneſs and ſtools, but without abating the ſwelling, and was obliged at length to ſubmit to the operation of tapping.

8. A man about ſixty-ſeven, who had long been accuſtomed to ſpirituous potation, had ſome time laboured under aſcites; his legs ſomewhat ſwelled; his breath eaſy in all attitudes; no appetite; great thirſt; urine in exceedingly ſmall quantity, very deep coloured, and turbid; pulſe equal. He took the foxglove in ſuch quantity as vomited him, and induced ſickneſs for two days; but procured no flow of urine, or diminution of his ſwelling; but was thought to leave him conſiderably weaker.

9. A corpulent man, accuſtomed to large potation of fermented liquors, had vehement cough, difficult breathing, anaſarca of his legs, thighs, and hands, and conſiderable tumour, with evident fluctuation of his abdomen; his pulſe was equal; his urine in ſmall quantity, of deep colour, and turbid. Theſe ſwellings had been twice conſiderably abated by draſtic cathartics. He took three ounces of a decoction of foxglove (made by boiling one ounce of

of the freſh leaves in a pint of water) every three hours, for two whole days; it then began to vomit and purge him violently, and promoted a great flow of urine; he was by theſe evacuations completely emptied in twelve hours. After two or three months all theſe ſymptoms returned, and were again relieved by the uſe of the foxglove; and thus in the ſpace of about three years he was about ten times evacuated, and continued all that time his uſual potations: excepting at firſt, the medicine operated only by urine, and did not appear conſiderably to weaken him.—The laſt time he took it, it had no effect; and a few weeks afterwards he vomited a great quantity of blood, and expired.

QUERIES.

1. As the firſt ſix of theſe patients had a due diſcharge of urine, and of the natural colour, was not the ſeat of the diſeaſe confined to ſome part of the thorax, and the ſwelling of the legs rather a ſymptom of the obſtructed circulation of the blood, than of a paralyſis of the cellular lymphatics of thoſe parts?

2. When the original diſeaſe is a general anaſarca, do not the cutaneous lymphatics always become paralytic at the ſame time with the cellular ones, by their greater ſympathy with each other? and hence the paucity of urine, and the great thirſt, diſtinguiſh this kind of dropſy?

3. In the anaſarca of the lungs, when the diſeaſe is not very great, though the patients have conſiderable difficulty of breathing at their firſt lying down, yet after a minute or two their breath becomes eaſy again; and the ſame occurs at their firſt riſing. Is not this owing to the time neceſſary for

for the fluid in the cells of the lungs to change its place, ſo as the leaſt to incommode reſpiration in the new attitude?

4. In the dropſy of the pericardium does not the patient bear the horizontal or perpendicular attitude with equal eaſe? Does this circumſtance diſtinguiſh the dropſy of the pericardium from that of the lungs and of the thorax?

5. Do the univerſal ſweats diſtinguiſh the dropſy of the pericardium, or of the thorax? and thoſe, which cover the upper parts of the body only, the anaſarca of the lungs?

6. When in the dropſy of the thorax, the patient endeavours to lie down, does not the extravaſated fluid compreſs the upper parts of the bronchia, and totally preclude the acceſs of air to every part of the lungs; whilſt in the perpendicular attitude the inferior parts of the lungs only are compreſſed? Does not ſomething ſimilar to this occur in the anaſarca of the lungs, when the diſeaſe is very great, and thus prevent thoſe patients alſo from lying down?

7. As a principal branch of the fourth cervical nerve of the left ſide, after having joined a branch of the third and of the ſecond cervical nerves, deſcending between the ſubclavian vein and artery, is received in a groove formed for it in the pericardium, and is obliged to make a conſiderable turn outwards to go over the prominent part of it, where the point of the heart is lodged, in its courſe to the diaphragm; and as the other phrenic nerve of the right ſide has a ſtraight courſe to the diaphragm; and as many other conſiderable branches of this fourth pair of cervical nerves are ſpread on the arms; does not a pain in the left arm diſtinguiſh a diſeaſe of the pericardium, as in the angina pectoris, or in the dropſy of the pericardium? and

does

does not a pain or weakneſs in both arms diſtinguiſh the dropſy of the thorax?

8. Do not the dropſies of the thorax and pericardium frequently exiſt together, and thus and to the uncertainty and fatality of the diſeaſe?

9. Might not the foxglove be ſerviceable in hydrocephalus internus, in hydrocele, and in white ſwellings of the joints?

VI. *Of cold Sweats.*

There have been hiſtories given of chronical immoderate ſweatings, which bear ſome analogy to the diabetes. Dr. Willis mentions a lady then living, whoſe ſweats were for many years ſo profuſe, that all her bed-clothes were not only moiſtened, but deluged with them every night; and that many ounces, and ſometimes pints, of this ſweat, were received in veſſels properly placed, as it trickled down her body. He adds, that ſhe had great thirſt, had taken many medicines, and ſubmitted to various rules of life, and changes of climate, but ſtill continued to have theſe immoderate ſweats. Pharmac. ration. de ſudore anglico.

Dr. Willis has alſo obſerved, that the ſudor anglicanus which appeared in England, in 1483, and continued till 1551, was in ſome reſpects ſimilar to the diabetes; and as Dr. Caius, who ſaw this diſeaſe, mentions the viſcidity, as well as the quantity of theſe ſweats, and adds, that the extremities were often cold, when the internal parts were burnt up with heat and thirſt, with great and ſpeedy emaciation and debility: there is great reaſon to believe, that the fluids were abſorbed from the cells of the body by the cellular and cyſtic branches of the lymphatics, and poured on the ſkin by the retrograde motions of the cutaneous ones.

Sydenham

Sydenham has recorded, in the ſtationary fever of the year 1685, the viſcid ſweats flowing from the head, which were probably from the ſame ſource, as thoſe in the ſweating plague above mentioned.

It is very common in dropſies of the cheſt or lungs to have the difficulty of breathing relieved by copious ſweats, flowing from the head and neck. Mr. P. about 50 years of age, had for many weeks been afflicted with anaſarca of his legs and thighs, attended with difficulty of breathing; and had repeatedly been relieved by ſquill, other bitters, and chalybeates.—One night the difficulty of breathing became ſo great, that it was thought he muſt have expired; but ſo copious a ſweat came out of his head and neck, that in a few hours ſome pints, by eſtimation, were wiped off from thoſe parts, and his breath was for a time relieved. This dyſpnœa and theſe ſweats recurred at intervals, and after ſome weeks he ceaſed to exiſt. The ſkin of his head and neck felt cold to the hand, and appeared pale at the time theſe ſweats flowed ſo abundantly; which is a proof, that they were produced by an inverted motion of the abſorbents of thoſe parts; for ſweats, which are the conſequence of an increaſed action of the ſanguiferous ſyſtem, are always attended with a warmth of the ſkin, greater than is natural, and a more florid colour; as the ſweats from exerciſe, or thoſe that ſucceed the cold fits of agues. Can any one explain how theſe partial ſweats ſhould relieve the difficulty of breathing in anaſarca, but by ſuppoſing that the pulmonary branch of abſorbents drank up the fluid in the cavity of the thorax, or in the cells of the lungs, and threw it on the ſkin, by the retrograde motions of the cutaneous branch? for, if we could ſuppoſe, that the increaſed action of the cutaneous glands or capillaries poured upon the ſkin this fluid, previouſly abſorbed from the lungs; why is not the whole ſurface of the body covered

covered with ſweat? why is not the ſkin warm? Add to this, that the ſweats above-mentioned were clammy or glutinous, which the condenſed perſpirable matter is not; whence it would ſeem to have been a different fluid from that of common perſpiration.

Dr. Dobſon, of Liverpool, has given a very ingenious explanation of the acid ſweats, which he obſerved in a diabetic patient—he thinks part of the chyle is ſecreted by the ſkin, and afterwards undergoes an acetous fermentation.—Can the chyle get thither, but by an inverted motion of the cutaneous lymphatics? in the ſame manner as it is carried to the bladder, by the inverted motions of the urinary lymphatics. Medic. Obſervat. and Enq. London, vol. v.

Are not the cold ſweats in ſome fainting fits, and in dying people, owing to an inverted motion of the cutaneous lymphatics? for in theſe there can be no increaſed arterial or glandular action.

Is the difficulty of breathing, ariſing from anaſarca of the lungs, relieved by ſweats from the head and neck; whilſt that difficulty of breathing, which ariſes from a dropſy of the thorax, or pericardium, is never attended with theſe ſweats of the head? and thence can theſe diſeaſes be diſtinguiſhed from each other? Do the periodic returns of nocturnal aſthma riſe from a temporary dropſy of the lungs, collected during their more torpid ſtate in ſound ſleep, and then re-abſorbed by the vehement efforts of the diſordered organs of reſpiration, and carried off by the copious ſweats about the head and neck?

More extenſive and accurate diſſections of the lymphatic ſyſtem are wanting to enable us to unravel theſe knots of ſcience.

VII. *Tranſlations*

VII. *Tranſlations of Matter, of Chyle, of Milk, of Urine. Operation of purging Drugs applied externally.*

1. The tranſlations of matter from one part of the body to another, can only receive an explanation from the doctrine of the occaſional retrograde motions of ſome branches of the lymphatic ſyſtem: for how can matter, abſorbed and mixed with the whole maſs of blood, be ſo haſtily collected again in any one part? and is it not an immutable law, in animal bodies, that each gland can ſecrete no other, but its own proper fluid? which is, in part, fabricated in the very gland by an animal proceſs, which it there undergoes: of theſe purulent tranſlations innumerable and very remarkable inſtances are recorded.

2. The chyle, which is ſeen among the materials thrown up by violent vomiting, or in purging ſtools, can only come thither by its having been poured into the bowels by the inverted motions of the lacteals: for our aliment is not converted into chyle in the ſtomach or inteſtines by a chemical proceſs, but is made in the very mouths of the lacteals; or in the meſenteric glands; in the ſame manner as other ſecreted fluids are made by an animal proceſs in their adapted glands.

Here a curious phænomenon in the exhibition of mercury is worth explaining:—If a moderate doſe of calomel, or ſix or ten grains, be ſwallowed, and within one or two days a cathartic is given, a ſalivation is prevented: but after three or four days, a ſalivation having come on, repeated purges every day, for a week or two, are required to eliminate the mercury from the conſtitution. For this acrid metallic preparation, being abſorbed by the mouths of the lacteals, continues, for a time arreſted by the meſenteric

meſenteric glands, (as the variolous or venereal poiſons ſwell the ſubaxillar or inguinal glands): which, during the operation of a cathartic, is returned into the inteſtines by the inverted action of the lacteals, and thus carried out of the ſyſtem.

Hence we underſtand the uſe of vomits or purges, to thoſe who have ſwallowed either contagious or poiſonous materials, even though exhibited a day or even two days after ſuch accidents; namely, that by the retrograde motions of the lacteals and lymphatics, the material ſtill arreſted in the meſenteric, or other glands, may be eliminated from the body.

3. Many inſtances of milk and chyle found in ulcers are given by Haller, El. Phyſiol. t. 7. p. 12, 23, which admit of no other explanation than by ſuppoſing, that the chyle, imbibed by one branch of the abſorbent ſyſtem, was carried to the ulcer, by the inverted motions of another branch of the ſame ſyſtem.

4. Mrs. P. on the ſecond day after delivery, was ſeized with a violent purging, in which, though opiates, mucilages, the bark, and teſtacea were profuſely uſed, continued many days, till at length ſhe recovered. During the time of this purging, no milk could be drawn from her breaſts; but the ſtools appeared like the curd of milk broken into ſmall pieces. In this caſe, was not the milk taken up from the follicles of the pectoral glands, and thrown on the inteſtines, by a retrogreſſion of the inteſtinal abſorbents? for how can we for a moment ſuſpect that the mucous glands of the inteſtines could ſeparate pure milk from the blood? Dr. Smelly has obſerved, that looſe ſtools, mixed with milk, which is curdled in the inteſtines, frequently relieves the turgeſcency of the breaſts of thoſe who ſtudiouſly repel their milk. Caſes in Midwifery, 43, No. 2. 1.

5. J. F.

5. J. F. Meckel obſerved in a patient, whoſe urine was in ſmall quantity and high coloured, that a copious ſweat under the arm-pits, of a perfectly urinous ſmell, ſtained the linen; which ceaſed again when the uſual quantity of urine was diſcharged by the urethra. Here we muſt believe from analogy, that the urine was firſt ſecreted in the kidneys, then re-abſorbed by the increaſed action of the urinary lymphatics, and laſtly carried to the axillæ by the retrograde motions of the lymphatic branches of thoſe parts. As in the jaundice it is neceſſary, that the bile ſhould firſt be ſecreted by the liver, and re-abſorbed into the circulation, to produce the yellowneſs of the ſkin; as was formerly demonſtrated by the late Dr. Munro, (Edin. Medical Eſſays) and if in this patient the urine had been re-abſorbed into the maſs of blood, as the bile in the jaundice, why was it not detected in other parts of the body, as well as in the arm-pits?

6. Cathartic and vermifuge medicines applied externally to the abdomen, ſeem to be taken up by the cutaneous branch of lymphatics, and poured on the inteſtines by the retrograde motions of the lacteals, without having paſſed the circulation.

For when the draſtic purges are taken by the mouth, they excite the lacteals of the inteſtines into retrograde motions, as appears from the chyle, which is found coagulated among the fæces, as was ſhewn above, (ſect. 2 and 4.) And as the cutaneous lymphatics are joined with the lacteals of the inteſtines, by frequent anaſtomoſes; it would be more extraordinary, when a ſtrong purging drug, abſorbed by the ſkin, is carried to the anaſtomoſing branches of the lacteals unchanged, if it ſhould not excite them into retrograde action as efficaciouſly,

as

as if it was taken by the mouth, and mixed with the food of the ſtomach.

VIII. *Circumſtances by which the Fluids, that are effuſed by the retrograde Motions of the abſorbent Veſſels, are diſtinguiſhed.*

1. We frequently obſerve an unuſual quantity of mucus or other fluids in ſome diſeaſes, although the action of the glands, by which theſe fluids are ſeparated from the blood, is not unuſually increaſed; but when the power of abſorption alone is diminiſhed. Thus the catarrhal humour from the noſtrils of ſome, who ride in froſty weather; and the tears, which run down the cheeks of thoſe, who have an obſtruction of the puncta lacrymalia; and the ichor of thoſe phagedenic ulcers, which are not attended with inflammation, are all inſtances of this circumſtance.

Theſe fluids however are eaſily diſtinguiſhed from others by their abounding in ammoniacal or muriatic ſalts; whence they inflame the circumjacent ſkin: thus in the catarrh the upper lip becomes red and ſwelled from the acrimony of the mucus, and patients complain of the ſaltneſs of its taſte. The eyes and cheeks are red with the corroſive tears, and the ichor of ſome herpetic eruptions erodes far and wide the contiguous parts, and is pungently ſalt to the taſte, as ſome patients have informed me.

Whilſt, on the contrary, thoſe fluids, which are effuſed by the retrograde action of the lymphatics, are for the moſt part mild and innocent; as water, chyle, and the natural mucus: or they take their properties from the materials previouſly abſorbed,

as

as in the coloured or vinous urine, or that ſcented with aſparagus, deſcribed before.

2. Whenever the ſecretion of any fluid is increaſed, there is at the ſame time an increaſed heat in the part; for the ſecreted fluid, as the bile, did not previouſly exiſt in the maſs of blood, but a new combination is produced in the gland. Now as ſolutions are attended with cold, ſo combinations are attended with heat; and it is probable the ſum of the heat given out by all the ſecreted fluids of animal bodies may be the cauſe of their general heat above that of the atmoſphere.

Hence the fluids derived from increaſed ſecretions are readily diſtinguiſhed from thoſe originating from the retrograde motions of the lymphatics: thus an increaſe of heat either in the diſeaſed parts, or diffuſed over the whole body, is perceptible, when copious bilious ſtools are conſequent to an inflamed liver; or a copious mucous ſalivation from the inflammatory angina.

3. When any ſecreted fluid is produced in an unuſual quantity, and at the ſame time the power of abſorption is increaſed in equal proportion, not only the heat of the gland becomes more intenſe, but the ſecreted fluid becomes thicker and milder, its thinner and ſaline parts being re-abſorbed: and theſe are diſtinguiſhable both by their greater conſiſtence, and by their heat, from the fluids, which are effuſed by the retrograde motions of the lymphatics; as is obſervable towards the termination of gonorrhœa, catarrh, chincough, and in thoſe ulcers, which are ſaid to abound with laudable pus.

4. When chyle is obſerved in ſtools, or among the materials ejected by vomit, we may be confident it muſt have been brought thither by the retrograde motions of the lacteals; for chyle does not previouſly exiſt amid the contents of the inteſtines, but

but is made in the very mouth of the lacteals, as was before explained.

5. When chyle, milk, or other extraneous fluids are found in the urinary bladder, or in any other excretory receptacle of a gland; no one can for a moment believe, that these have have been collected from the mass of blood by a morbid secretion, as it contradicts all analogy.

——— Aurea duræ
Mala ferant quercus? Narcisso floreat alnus?
Pinguia corticibus sudent electra myricæ?

VIRGIL.

IX. *Retrograde Motions of Vegetable Juices.*

THERE are besides some motions of the sap in vegetables, which bear analogy to our present subject; and as the vegetable tribes are by many philosophers held to be inferior animals, it may be a matter of curiosity at least to observe, that their absorbent vessels seem evidently, at times, to be capable of a retrograde motion. Mr. Perault cut off a forked branch of a tree, with the leaves on; and inverting one of the forks into a vessel of water, observed that the leaves on the other branch continued green much longer than those of a similar branch, cut off from the same tree; which shews, that the water from the vessel was carried up one part of the forked branch, by the retrograde motion of its vessels, and supplied nutriment some time to the other part of the branch, which was out of the water. And the celebrated Dr. Hales found, by numerous very accurate experiments, that the sap of trees rose upwards during the warmer hours of the day, and in part descended again during the cooler ones. Vegetable Statics.

It

It is well known that the branches of willows, and of many other trees, will either take root in the earth or engraft on other trees, ſo as to have their natural direction inverted, and yet flouriſh with vigour.

Dr Hope has alſo made this pleaſing experiment, after the manner of Hales—he has placed a forked branch, cut from one tree, erect between two others; then cutting off a part of the bark from one fork applied it to a ſimilar branch of one of the trees in its vicinity; and the ſame of the other fork; ſo that a tree is ſeen to grow ſuſpended in the air, between two other trees; which ſupply their foſter friend with due nouriſhment.

Miranturque novas frondes, et non ſua poma.

All theſe experiments clearly evince, that the juices of vegetables can occaſionally paſs either upwards or downwards in their abſorbent ſyſtem of veſſels.

X. *Objections anſwered.*

The following experiment, at firſt view, would ſeem to invalidate this opinion of the retrograde motions of the lymphatic veſſels, in ſome diſeaſes.

About a gallon of milk having been given to an hungry ſwine, he was ſuffered to live about an hour, and was then killed by a ſtroke or two on his head with an axe.—On opening his belly the lacteals were well ſeen filled with chyle; on irritating many of the branches of them with a knife, they did not appear to empty themſelves haſtily; but they did however carry forwards their contents in a little time.

I then

I then paſſed a ligature round ſeveral branches of lacteals, and irritated them much with a knife beneath the ligature, but could not make them regurgitate their contained fluid in o the bowels.

I am not indeed certain, that the nerve was not at the ſame time included in the ligature, and thus the lymphatic rendered unirritable or lifeleſs; but this however is certain, that it is not any quantity of any ſtimulus, which induces the veſſels of animal bodies to revert their motions; but a certain quantity of a certain ſtimulus, as appears from wounds in the ſtomach, which do not produce vomiting; and wounds of the inteſtines, which do not produce the cholera morbus.

At Nottingham, a few years ago, two ſhoemakers quarrelled, and one of them with a knife, which they uſe in their occupation, ſtabbed his companion about the region of the ſtomach. On opening the abdomen of the wounded man after his death, the food and medicines he had taken were in part found in the cavity of the belly, on the outſide of the bowels; and there was a wound about half an inch long at the bottom of the ſtomach; which I ſuppoſe was diſtended with liquor and food at the time of the accident; and thence was more liable to be injured at its bottom: but during the whole time he lived, which was about ten days, he had no efforts to vomit, nor ever even complained of being ſick at the ſtomach! Other caſes ſimilar to this are mentioned in the philoſophical tranſactions.

Thus, if you vellicate the throat with a feather, nauſea is produced; if you wound it with a penknife, pain is induced, but not ſickneſs. So if the ſoles of the feet of children or their armpits are tickled, convulſive laughter is excited, which ceaſes the moment the hand is applied, ſo as to rub them more forcibly.

The experiment therefore above related upon the lacteals of a dead pig, which were included in a ſtrict ligature, proves nothing; as it is not the quantity, but the kind of ſtimulus, which excites the lymphatic veſſels into retrograde motion.

XI. *The Cauſes which induce the retrograde Motions of animal Veſſels; and the Medicines by which the natural Motions are reſtored.*

1. Such is the conſtruction of animal bodies, that all their parts, which are ſubjected to leſs ſtimuli than nature deſigned, perform their functions with leſs accuracy: thus, when too watery or too aceſcent food is taken into the ſtomach, indigeſtion, and flatulency, and heart-burn ſucceed.

2. Another law of irritation, connate with our exiſtence, is, that all thoſe parts of the body, which have previouſly been expoſed to too great a quantity of ſuch ſtimuli, as ſtrongly affect them, become for ſome time afterwards diſobedient to the natural quantity of their adapted ſtimuli.—Thus the eye is incapable of ſeeing objects in an obſcure room, though the iris is quite dilated, after having been expoſed to the meridian ſun.

3. There is a third law of irritation, that all the parts of our bodies, which have been lately ſubjected to leſs ſtimulus, than they have been accuſtomed to, when they are expoſed to their uſual quantity of ſtimulus, are excited into more energetic motions: thus when we come from a duſky cavern into the glare of daylight, our eyes are dazzled; and after emerging from the cold bath, the ſkin becomes warm and red.

4. There is a fourth law of irritation, that all the parts of our bodies, which are ſubjected to ſtill ſtronger ſtimuli for a length of time, become torpid, and refuſe to obey even theſe ſtronger ſtimuli; and

and thence do their offices very imperfectly.—Thus, if any one looks earneſtly for ſome minutes on an area, an inch diameter, of red ſilk, placed on a ſheet of white paper, the image of the ſilk will gradually become pale, and at length totally vaniſh.

5. Nor is it the nerves of ſenſe alone, as the optic and auditory nerves, that thus become torpid, when the ſtimulus is withdrawn or their irritability decreaſed; but the motive muſcles, when they are deprived of their natural ſtimuli, or of their irritability, become torpid and paralytic; as is ſeen in the tremulous hand of the drunkard in a morning; and in the awkward ſtep of age.

The hollow muſcles alſo, of which the various veſſels of the body are conſtructed, when they are deprived of their natural ſtimuli, or of their due degree of irritability, not only become tremulous, as the arterial pulſations of dying people; but alſo frequently invert their motions, as in vomiting, in hyſteric ſuffocations, and diabetes above deſcribed.

I muſt beg your patient attention, for a few moments, whilſt I endeavour to explain how the retrograde actions of our hollow muſcles are the conſequence of their debility; as the tremulous actions of the ſolid muſcles are the conſequence of their debility. When, through fatigue, a muſcle can act no longer, the antagoniſt muſcles, either by their inanimate elaſticity, or by their animal action, draw the limb into a contrary direction: in the ſolid muſcles, as thoſe of locomotion, their actions are aſſociated in tribes, which have been accuſtomed to ſynchronous action only; hence when they are fatigued, only a ſingle contrary effort takes place; which is either tremulous, when the fatigued muſcles are again immediately brought into action; or it is a pandiculation, or ſtretching, where they are not immediately again brought into action.

Now the motions of the hollow muſcles, as they in general propel a fluid along their cavities, are aſ-

ſociated in trains, which have been accuſtomed to ſucceſſive actions: hence when one ring of ſuch a muſcle is fatigued from its too great debility, and is brought into retrograde action, the next ring from its aſſociation falls ſucceſſively into retrograde action, and ſo on throughout the whole canal. See Sect. XXV. 6.

6. But as the retrograde motions of the ſtomach, œſophagus, and fauces in vomiting are, as it were, apparent to the eye; we ſhall conſider this operation more minutely, that the ſimilar operations in the more recondite parts of our ſyſtem may be eaſier underſtood

From certain nauſeous ideas of the mind, from an ungrateful taſte in the mouth, or from fœtid ſmells, vomiting is ſometimes inſtantly excited; or even from a ſtroke on the head, or from the vibratory motions of a ſhip; all which originate from aſſociation, or ſympathy. See Sect. XX. on Vertigo.

But when the ſtomach is ſubjected to a leſs ſtimulus than is natural, according to the firſt law of irritation mentioned above, its motions become diſturbed, as in hunger; firſt pain is produced, then ſickneſs, and at length vain efforts to vomit, as many authors inform us.

But when a great quantity of wine, or of opium, is ſwallowed, the retrograde motions of the ſtomach do not occur till after ſeveral minutes, or even hours; for when the power of ſo ſtrong a ſtimulus ceaſes, according to the ſecond law of irritation, mentioned above, the periſtaltic motions become tremulous, and at length retrograde; as is well known to the drunkard, who on the next morning has ſickneſs and vomitings.

When a ſtill greater quantity of wine, or of opium, or when nauſeous vegetables, or ſtrong bitters, or metallic ſalts, are taken into the ſtomach, they quickly induce vomiting; though all theſe in leſs doſes

doſes excite the ſtomach into more energetic action and ſtrengthen the digeſtion; as the flowers of chamomile, and the vitriol of zinc: for, according to the fourth law of irritation, the ſtomach will not long be obedient to a ſtimulus ſo much greater than is natural; but its action becomes firſt tremulous and then retrograde.

7. When the motions of any veſſels become retrograde, leſs heat of the body is produced; for in paroxyſms of vomiting, of hyſteric affections, of diabetes, of aſthma, the extremities of the body are cold; hence we may conclude, that theſe ſymptoms ariſe from the debility of the parts in action; for an increaſe of muſcular action is always attended with increaſe of heat.

8. But as animal debility is owing to defect of ſtimulus, or to defect of irritability, as ſhewn above, the method of cure is eaſily deduced: when the vaſcular muſcles are not excited into their due action by the natural ſtimuli, we ſhould exhibit thoſe medicines, which poſſeſs a ſtill greater degree of ſtimulus; amongſt theſe are the fœtids, the volatiles, aromatics, bitters, metallic ſalts, opiates, wine, which indeed ſhould be given in ſmall doſes, and frequently repeated. To theſe ſhould be added conſtant, but moderate exerciſe, cheerfulneſs of mind, and change of country to a warmer climate; and perhaps occaſionally the external ſtimulus of bliſters.

It is alſo frequently uſeful to diminiſh the quantity of natural ſtimulus for a ſhort time, by which afterwards the irritability of the ſyſtem becomes increated; according to the third law of irritation above-mentioned, hence the uſe of baths ſomewhat colder than animal heat, and of equitation in the open air.

The catalogue of diſeaſes owing to the retrograde motions of lymphatics is here omitted, as it will appear in the ſecond volume of this work. The following is the concluſion to this theſis of Mr. CHARLES DARWIN.

THUS have I endeavoured in a conciſe manner to explain the numerous diſeaſes, which deduce their origin from the inverted motions of the hollow muſcles of our bodies; and it is probable, that Saint Vitus's dance, and the ſtammering of ſpeech, originate from a ſimilar inverted order of the aſſociated motions of ſome of the ſolid muſcles; which, as it is foreign to my preſent purpoſe, I ſhall not here diſcuſs.

I beg, illuſtrious profeſſors, and ingenious fellow-ſtudents, that you will recollect how difficult a taſk I have attempted, to evince the retrograde motions of the lymphatic veſſels, when the veſſels themſelves for ſo many ages eſcaped the eyes and glaſſes of philoſophers: and if you are not yet convinced of the truth of this theory, hold, I entreat you, your minds in ſuſpenſe, till ANATOMY draws her ſword with happier omens, cuts aſunder the knots which entangle PHYSIOLOGY; and, like an augur inſpecting the immolated victim, announces to mankind the wiſdom of HEAVEN.

SECT.

SECT. XXX.

PARALYSIS OF THE LIVER AND KIDNEYS.

1. *Bile-ducts less irritable after having been stimulated much.* 2. *Jaundice from paralysis of the bile-ducts cured by electric shocks.* 3. *From bile-stones. Experiments on bile-stones. Oil vomit.* 4. *Palsy of the liver, two causes.* 5. *Schirrosity of the liver.* 6. *Large livers of geese.* II. *Paralysis of the kidneys.* III. *Story of Prometheus.*

1. FROM the ingurgitation of spirituous liquors into the stomach and duodenum, the termination of the common bile-duct in that bowel becomes stimulated into unnatural action, and a greater quantity of bile is produced from all the secretory vessels of the liver, by the association of their motions with those of their excretory ducts; as has been explained in Section XXIV. and XXV. but as all parts of the body, that have been affected with stronger stimuli for any length of time, become less susceptible of motion, from their natural weaker stimuli, it follows, that the motions of the secretory vessels, and in consequence the secretion of bile, is less than is natural during the intervals of sobriety. 2. If this ingurgitation of spirituous liquors has been daily continued in considerable quantity, and is then suddenly intermitted, a languor or paralysis of the common bile-duct is induced; the bile is prevented from being poured into the intestines; and as the bilious absorbents are stimulated into stronger action by its accumulation, and by the acrimony or viscidity, which it acquires by delay, it is absorbed, and carried

carried to the receptacle of the chyle; or otherwiſe the ſecretory veſſels of the liver, by the above-mentioned ſtimulus, invert their motions, and regurgitate their contents into the blood, as ſometimes happens to the tears in the lachrymal ſack, ſee Sect. XXIV. 2. 7. and one kind of jaundice is brought on.

There is reaſon to believe, that the bile is moſt frequently returned into the circulation by the inverted motions of theſe hepatic glands, for the bile does not ſeem liable to be abſorbed by the lymphatics, for it ſoaks through the gall-ducts, and is frequently found in the cellular membrane. This kind of jaundice is not generally attended with pain, neither at the extremity of the bile-duct, where it enters the duodenum, nor on the region of the gall-bladder.

Mr. S. a gentleman between 40 and 50 years of age, had had the jaundice about ſix weeks, without pain, ſickneſs, or fever; and had taken emetics, cathartics, mercurials, bitters, chalybeates, eſſential oil, and æther, without apparent advantage. On a ſuppoſition that the obſtruction of the bile might be owing to the paralyſis, or torpid action of the common bile-duct, and the ſtimulants taken into the ſtomach ſeeming to have no effect, I deſired half a ſcore ſmart electric ſhocks from a coated bottle, which held about a quart, to be paſſed through the liver, and along the courſe of the common gall-duct, as near as could be gueſſed, and on that very day the ſtools became yellow; he continued the electric ſhocks a few days more, and his ſkin gradually became clear.

3. The bilious vomiting and purging, that affects ſome people by intervals of a few weeks, is a leſs degree of this diſeaſe; the bile duct is leſs irritable than natural, and hence the bile becomes accumulated in the gall-bladder, and hepatic ducts, till by its quantity, acrimony or viſcidity, a greater degree of irritation is produced, and it is ſuddenly evacuated

ated, or laſtly from the abſorption of the more liquid parts of the bile, the remainder becomes inſpiſſated, and cryſtallizes into maſſes too large to paſs, and forms another kind of jaundice, where the bile-duct is not quite paralytic, or has regained its irritability.

This diſeaſe is attended with much pain, which at firſt is felt at the pit of the ſtomach, exactly in the centre of the body, where the bile-duct enters the duodenum; afterwards, when the ſize of the bile-ſtones increaſe, it is alſo felt on the right ſide, where the gall-bladder is ſituated. The former pain at the pit of the ſtomach recurs by intervals, as the bile-ſtone is puſhed againſt the neck of the duct; like the paroxyſms of the ſtone in the urinary bladder, the other is a more dull and conſtant pain.

Where theſe bile-ſtones are too large to paſs, and the bile-ducts poſſeſs their ſenſibility, this becomes a very painful and hopeleſs diſeaſe. I made the following experiments with a view to their chemical ſolution.

Some fragments of the ſame bile-ſtone were put nto the weak ſpirit of marine ſalt, which is ſold in the ſhops, and into ſolution of mild alcali; and into a ſolution of cauſtic alcali; and into oil of turpentine; without their being diſſolved. All theſe mixtures were after ſome time put into a heat of boiling water, and then the oil of turpentine diſſolved its fragments of bile-ſtone, but no alteration was produced upon thoſe in the other liquids except ſome change of their colour.

Some fragments of the ſame bile-ſtone were put into vitriolic æther, and were quickly diſſolved without additional heat. Might not æther mixed with yolk of egg or with honey be given advantageouſly in bilious concretions?

I have in two inſtances ſeen from 30 to 50 bile-ſtones come away by ſtool, about the ſize of large peas

peas, after having given ſix grains of calomel in the evening, and four ounces of oil of almonds or olives on the ſucceeding morning. I have alſo given half a pint of good olive or almond oil as an emetic during the painful fit, and repeated it in half an hour, if the firſt did not operate, with frequent good effect.

4. Another diſeaſe of the liver, which I have ſeveral times obſerved, conſiſts in the inability or paralyſis of the ſecretory veſſels. This diſeaſe has generally the ſame cauſe as the preceding one, the too frequent potation of ſpirituous liquors, or the too ſudden omiſſion of them, after the habit is confirmed; as is greater or leſs in proportion, as the whole or a part of the liver is affected, and as the inability or paralyſis is more or leſs complete.

This palſy of the liver is known from theſe ſymptoms, the patients have generally paſſed the meridian of life, have drank fermented liquors daily, but perhaps not been opprobrious drunkards; they loſe their appetite, then their fleſh and ſtrength diminiſh in conſequence, there appears no bile in their ſtools, nor in their urine, nor is any hardneſs or ſwelling perceptible on the region of the liver. But what is peculiar to this diſeaſe, and diſtinguiſhes it from all others at the firſt glance of the eye, is the bombycinous colour of the ſkin, which, like that of full-grown ſilkworms, has a degree of tranſparency with a yellow tint not greater than is natural to the ſerum of the blood.

Mr. C. and Mr. B. both very ſtrong men, between 50 and 60 years of age, who had drank ale at their meals inſtead of ſmall beer, but were not reputed hard drinkers, ſuddenly became weak, loſt their appetite, fleſh and ſtrength, with all the ſymptoms above enumerated, and died in about two months from the beginning of their malady. Mr. C. became anaſarcous a few days before his death, and

and Mr. B. had frequent and great hæmorrhages from an iſſue, and ſome parts of his mouth, a few days before his death. In both theſe caſes calomel, bitters and chalybeates were repeatedly uſed without effect.

One of the patients deſcribed above, Mr. C. was by trade a plumber; both of them could digeſt no food, and died apparently for want of blood. Might not the transfuſion of blood be uſed in theſe caſes with advantage?

5. When the paralyſis of the hepatic glands is leſs complete, or leſs univerſal, a ſchirroſity of ſome part of the liver is induced; for the ſecretory veſſels retaining ſome of their living power take up a fluid from the circulation, without being ſufficiently irritable to carry it forwards to their excretory ducts; hence the body, or receptacle of each gland, becomes inflated, and this diſtenſion increaſes, till, by its very great ſtimulus inflammation is produced, or till thoſe parts of the viſcus become totally paralytic. This diſeaſe is diſtinguiſhable from the foregoing by the palpable hardneſs or largeneſs of the liver; and as the hepatic glands are not totally paralytic, or the whole liver not affected, ſome bile continues to be made. The inflammations of this viſcus, conſequent to the ſchirroſity of it, belong to the diſeaſes of the ſenſitive motions, and will be treated of hereafter.

6. The ancients are ſaid to have poſſeſſed an art of increaſing the livers of geeſe to a ſize greater than the remainder of the gooſe. Martial. l. 13. epig. 58.—This is ſaid to have been done by fat and figs. Horace, l. 2. ſat. 8.—Juvenal ſets theſe large livers before an epicure as a great rarity. Sat. 5. l. 114; and Perſius, ſat. 6. l. 71. Pliny ſays theſe large gooſe-livers were ſoaked in mulled milk, that is, I ſuppoſe, milk mixed with honey and wine; and adds, "that it is uncertain whether Scipio Metellus, of

of conſular dignity, or M. Seſtius, a Roman knight, was the great diſcoverer of this excellent diſh." A modern traveller, I believe Mr. Brydone, aſſerts that the art of enlarging the livers of geeſe ſtill exiſts in Sicily; and it is to be lamented that he did not import it into his native country, as ſome method of affecting the human liver might perhaps have been collected from it; beſides the honour he might have acquired in improving our giblet pies.

Our wiſer caupones, I am told, know how to fatten their fowls, as well as their geeſe, for the London markets, by mixing gin inſtead of figs and fat with their food; by which they are ſaid to become ſleepy, and to fatten apace, and probably acquire enlarged livers; as the ſwine are aſſerted to do, which are fed on the ſediments of barrels in the diſtilleries; and which ſo frequently obtains in thoſe, who ingurgitate much ale, or wine, or drams.

II. The irritative diſeaſes of the kidneys, pancreas, ſpleen, and other glands, are analogous to thoſe of the liver above deſcribed, differing only in the conſequences attending their inability to action. For inſtance, when the ſecretory veſſels of the kidneys become diſobedient to the ſtimulus of the paſſing current of blood, no urine is ſeparated or produced by them; their excretory mouths become filled with concreted mucus, or calculus matter, and in eight or ten days ſtupor and death intervenes in conſequence of the retention of the feculent part of the blood.

This diſeaſe in a ſlighter degree, or when only a part of the kidney is affected, is ſucceeded by partial inflammation of the kidney in conſequence of previous torpor. In that caſe greater actions of the ſecretory veſſels occur, and the nucleus of gravel is formed by the inflamed mucous membranes of the tubuli uriniferi, as farther explained in its place.

This torpor or paralyſis of the ſecretory veſſels of the kidneys, like that of the liver, owes its origin

to

to their being previouſly habituated to too great ſtimulus; which in this country is generally owing to the alcohol contained in ale or wine; and hence muſt be regiſtered amongſt the diſeaſes owing to inebriety; though it may be cauſed by whatever occaſionally inflames the kidney; as too violent riding on horſeback, or the cold from a damp bed, or by ſleeping on the cold ground; or perhaps by drinking in general too little aqueous fluids.

III. I ſhall conclude this ſection on the diſeaſes of the liver induced by ſpirituous liquors, with the well known ſtory of Prometheus, which ſeems indeed to have been invented by phyſicians in thoſe ancient times, when all things were clothed in hieroglyphic, or in fable. Prometheus was painted as ſtealing fire from heaven, which might well repreſent the inflammable ſpirit produced by fermentation; which may be ſaid to animate or enliven the man of clay: whence the conqueſts of Bacchus, as well as the temporary mirth and noiſe of his devotees. But the after puniſhments of thoſe, who ſteal this accurſed fire, is a vulture gnawing the liver; and well allegoriſes the poor inebriate lingering for years under painful hepatic diſeaſes. When the expediency of laying a further tax on the diſtillation of ſpirituous liquors from grain was canvaſſed before the Houſe of Commons ſome years ago, it was ſaid of the diſtillers with great truth, "*They take the bread from the people, and convert it into poiſon!*" Yet is this manufactory of diſeaſe permitted to continue, as appears by its paying into the treaſury above 900,000*l.* near a million of money annually. And thus, under the names of rum, brandy, gin, whiſkey, uſquebaugh, wine, cyder, beer, and porter, alcohol is become the bane of

of the Chriſtian world, as opium of the Mahometan.

Evoe! parce, Liber?
Parce, gravi metuende thyrſo! Hor.

SECT. XXXI.

OF TEMPERAMENTS.

I. *The temperament of decreaſed irritability known by weak pulſe, large pupils of the eye, cold extremities. Are generally ſuppoſed to be too irritable. Bear pain better than labour. Natives of North-America contraſted with thoſe upon the coaſt of Africa. Narrow and broad ſhouldered people. Irritable conſtitutions bear labour better than pain.* II. *Temperament of increaſed ſenſibility. Liable to intoxication, to inflammation, hæmoptoe, gutta ſerena, enthuſiaſm, delirium, reverie. Theſe conſtitutions are indolent to voluntary exertions, and dull to irritations. The natives of South-America, and brute animals of this temperament.* III. *Of increaſed voluntarity; theſe are ſubject to locked jaw, convulſions, epilepſy, mania. Are very active, bear cold, hunger, fatigue. Are ſuited to great exertions. This temperament diſtinguiſhes mankind from other animals.* IV. *Of increaſed aſſociation. Theſe have great memories, are liable to quartan agues, and ſtronger ſympathies of parts with each other.* V. *Change of temperaments into one another.*

ANTIENT writers have ſpoken much of temperaments, but without ſufficient preciſion. By temperament

temperament of the ſyſtem ſhould be meant a permanent prediſpoſition to certain claſſes of diſeaſes: without this definition a temporary prediſpoſition to every diſtinct malady might be termed a temperament. There are four kinds of conſtitution, which permanently deviate from good health, and are perhaps ſufficiently marked to be diſtinguiſhed from each other, and conſtitute the temperaments or prediſpoſitions to the irritative, ſenſitive, voluntary, and aſſociate claſſes of diſeaſes.

I. *The Temperament of decreaſed Irritability.*

THE diſeaſes which are cauſed by irritation, moſt frequently originate from the defect of it; for thoſe which are immediately owing to the exceſs of it, as the hot fits of fever, are generally occaſioned by an accumulation of ſenſorial power in conſequence of a previous defect of irritation, as in the preceding cold fits of fever. Whereas the diſeaſes, which are cauſed by ſenſation and volition, moſt frequently originate from the exceſs of thoſe cenſorial powers, as will be explained below.

The temperament of decreaſed irritability appears from the following circumſtances, which ſhew that the muſcular fibres or organs of ſenſe are liable to become torpid or quieſcent from leſs defect of ſtimulation than is productive of torpor or quieſcence in other conſtitutions.

1. The firſt is the weak pulſe, which in ſome conſtitutions is at the ſame time quick. 2. The next moſt marked criterion of this temperament is the largeneſs of the aperture of the iris, or pupil of the eye, which has been reckoned by ſome a beautiful feature in the female countenance, as an indication of delicacy, but to an experienced obſerver it is an indication of debility, and is therefore

fore a defect, not an excellence. The third moſt marked circumſtance in this conſtitution is, that the extremities, as the hands and feet, or noſe and ears, are liable to become cold and pale in ſituations in reſpect to warmth, where thoſe of greater ſtrength are not affected. Thoſe of this temperament are ſubject to hyſteric affections, nervous fevers, hydrocephalus, ſcrophula, and conſumption, and to all other diſeaſes of debility.

Thoſe, who poſſeſs this kind of conſtitution, are popularly ſuppoſed to be more irritable than is natural, but are in reality leſs ſo. This miſtake has ariſen from their generally having a greater quickneſs of pulſe, as explained in Sect. XII. 1. 4. XII. 3. 3.; but this frequency of pulſe is not neceſſary to the temperament, like the debility of it.

Perſons of this temperament are frequently found amongſt the ſofter ſex, and amongſt narrow-ſhouldered men; who are ſaid to bear labour worſe, and pain better than others. This laſt circumſtance is ſuppoſed to have prevented the natives of North America from having been made ſlaves by the Europeans. They are a narrow ſhouldered race of people, and will rather expire under the laſh, than be made to labour. Some nations of Aſia have ſmall hands, as may be ſeen by the handles of their ſcymetars; which with their narrow ſhoulders ſhew, that they have not been accuſtomed to ſo great labour with their hands and arms, as the European nations in agriculture, and thoſe on the coaſts of Africa in ſwimming and rowing. Dr. Maningham, a popular accoucheur in the beginning of this century, obſerves in his aphoriſms, that broad ſhouldered men procreate broad ſhouldered children. Now as labour ſtrengthens the muſcles employed, and increaſes their bulk, it would ſeem that a few generations of labour or of indolence may in this reſpect

reſpect change the form and temperament of the body.

On the contrary, thoſe who are happily poſſeſſed of a great degree of irritability, bear labour better than pain; and are ſtrong, active, and ingenious. But there is not properly a temperament of increaſed irritability tending to diſeaſe, becauſe an increaſed quantity of irritative motions generally induces an increaſe of pleaſure or pain, as in intoxication, or inflammation; and then the new motions are the immediate conſequences of increaſed ſenſation, not of increaſed irritation; which have hence been ſo perpetually confounded with each other.

II. *Temperament of Senſibility.*

There is not properly a temperament, or prediſpoſition to diſeaſe, from decreaſed ſenſibility, ſince irritability and not ſenſibility is immediately neceſſary to bodily health. Hence it is the exceſs of ſenſation alone, as it is the defect of irritation, that moſt frequently produces diſeaſe. This temperament of increaſed ſenſibility is known from the increaſed activity of all thoſe motions of the organs of ſenſe and muſcles, which are exerted in conſequence of pleaſure or pain, as in the beginning of drunkenneſs, and in inflammatory fever. Hence thoſe of this conſtitution are liable to inflammatory diſeaſes, as hepatitis, and to that kind of conſumption which is hereditary, and commences with ſlight repeated hœmoptoe. They have high-coloured lips, frequently dark hair and dark eyes with large pupils, and are in that caſe ſubject to gutta ſerena. They are liable to enthuſiaſm, delirium, and reverie. In this laſt circumſtance they are liable to ſtart at the clapping of a door; becauſe the more intent any one is on the paſſing current of his ideas,

the greater ſurpriſe he experiences on their being diſſevered by ſome external violence, as explained in Sect. XIX. on reverie.

As in theſe conſtitutions more than the natural quantities of ſenſitive motions are produced by the increaſed quantity of ſenſation exiſting in the habit, it follows, that the irritative motions will be performed in ſome degree with leſs energy, owing to the great expenditure of ſenſorial power on the ſenſitive ones. Hence thoſe of this temperament do not attend to ſlight ſtimulations, as explained in Sect. XIX. But when a ſtimulus is ſo great as to excite ſenſation, it produces greater ſenſitive actions of the ſyſtem than in others; ſuch as delirium or inflammation. Hence they are liable to be abſent in company; ſit or lie long in one poſture; and in winter have the ſkin of their legs burnt into various colours by the fire. Hence alſo they are fearful of pain; covet muſic and ſleep; and delight in poetry and romance.

As the motions in conſequence of ſenſation are more than natural, it alſo happens from the greater expenditure of ſenſorial power on them, that the voluntary motions are leſs eaſily exerted. Hence the ſubjects of this temperament are indolent in reſpect to all voluntary exertions, whether of mind or body.

A race of people of this deſcription ſeems to have been found by the Spaniards in the iſlands of America, where they firſt landed, ten of whom are ſaid not to have conſumed more food than one Spaniard, nor to have been capable of more than one tenth of the exertion of a Spaniard. Robertſon's Hiſtory.—In a ſtate ſimilar to this the greateſt part of the animal world paſs their lives, between ſleep or inactive reverie, except when they are excited by the call of hunger.

III. *The*

III. *The Temperament of increaſed Voluntarity.*

Those of this conſtitution differ from both the laſt mentioned in this, that the pain, which gradually ſubſides in the firſt, and is productive of inflammation or delirium in the ſecond, is in this ſucceeded by the exertion of the muſcles or ideas, which are moſt frequently connected with volition; and they are thence ſubject to locked jaw, convulſions, epilepſy, and mania, as explained in Sect. XXXIV. Thoſe of this temperament attend to the ſlighteſt irritations or ſenſations, and immediately exert themſelves to obtain or avoid the objects of them, they can at the ſame time bear cold and hunger better than others, of which Charles the Twelfth of Sweden was an inſtance. They are ſuited and generally prompted to all great exertions of genius or labour, as their deſires are more extenſive and more vehement, and their powers of attention and of labour greater. It is this facility of voluntary exertion, which diſtinguiſhes men from brutes, and which has made them lords of the creation.

IV. *The Temperament of increaſed Aſſociation.*

This conſtitution conſiſts in the too great facility, with which the fibrous motions acquire habits of aſſociation, and by which theſe aſſociations become proportionably ſtronger than in thoſe of the other temperaments. Thoſe of this temperament are ſlow in voluntary exertions, or in thoſe dependent on ſenſation, or on irritation. Hence great memories have been ſaid to be attended with leſs ſenſe and leſs imagination from Ariſtotle down to

the preſent time; for by the word memory theſe writers only underſtood the unmeaning repetition of words or numbers in the order they were received, without any voluntary efforts of the mind.

In this temperament thoſe aſſociations of motions, which are commonly termed ſympathies, act with greater certainty and energy, as thoſe between diſturbed viſion and the inverſion of the motion of the ſtomach, as in ſea-ſickneſs; and the pains in the ſhoulder from hepatic inflammation. Add to this, that the catenated circles of actions are of greater extent than in the other conſtitutions. Thus if a ſtrong vomit or cathartic be exhibited in this temperament, a ſmaller quantity will produce as great an effect, if it be given ſome weeks afterwards; whereas in other temperaments this is only to be expected, if it be exhibited in a few days after the firſt doſe. Hence quartan agues are formed in thoſe of this temperament, as explained in Section XXXII. on diſeaſes from irritation, and other intermittents are liable to recur from ſlight cauſes many weeks after they have been cured by the bark.

V. The firſt of theſe temperaments differs from the ſtandard of health from defect, and the others from exceſs of ſenſorial power; but it ſometimes happens that the ſame individual, from the changes introduced into his habit by the different ſeaſons of the year, modes or periods of life, or by accidental diſeaſes, paſſes from one of theſe temperaments to another. Thus a long uſe of too much fermented liquor produces the temperament of increaſed ſenſibility; great indolence and ſolitude that of decreaſed irritability; and want of the neceſſaries of life that of increaſed voluntarity.

SECT.

SECT. XXXII.

DISEASES OF IRRITATION.

I. *Irritative fevers with ſtrong pulſe. With weak pulſe. Symptoms of fever. Their ſource.* II. 1. *Quick pulſe is owing to decreaſed irritability.* 2. *Not in ſleep or in apoplexy.* 3. *From inanition. Owing to deficiency of ſenſorial power.* III. 1. *Cauſes of fever. From defect of heat. Heat from ſecretions. Pain of cold in the loins and forehead.* 2. *Great expenſe of ſenſorial power in the vital motions. Immerſion in cold water. Succeeding glow of heat. Difficult reſpiration in cold bathing explained. Why the cold bath invigorates. Bracing and relaxation are mechanical terms.* 3. *Uſes of cold bathing. Uſes of cold air in fevers.* 4. *Ague fits from cold air. Whence their periodical returns.* IV. *Defect of diſtention a cauſe of fever. Deficiency of blood. Tranſfuſion of blood.* V. 1. *Defect of momentum of the blood from mechanic ſtimuli.* 2. *Air injected into the blood-veſſels.* 3. *Exerciſe increaſes the momentum of the blood.* 4. *Sometimes bleeding increaſes the momentum of it.* VI. *Influence of the ſun and moon on diſeaſes. The chemical ſtimulus of the blood. Menſtruation obeys the lunations. Queries.* VII. *Quieſcence of large glands a cauſe of fever. Swelling of the præcordia.* VIII. *Other cauſes of quieſcence, as hunger, bad air, fear, anxiety.* IX. 1. *Symptoms of the cold fit.* 2. *Of the hot fit.* 3. *Second cold fit why.* 4. *Inflammation introduced, or delirium, or ſtupor.* X. *Recapitulation. Fever*

not

not an effort of nature to relieve herſelf. Doctrine of ſpaſm.

1. WHEN the contractile ſides of the heart and arteries perform a greater number of pulſations in a given time, and move through a greater area at each pulſation, whether theſe motions are occaſioned by the ſtimulus of the acrimony or quantity of the blood, or by their aſſociation with other irritative motions, or by the increaſed irritability of the arterial ſyſtem, that is, by an increaſed quantity of ſenſorial power, one kind of fever is produced; which may be called Synocha irritativa, or Febris irritativa pulſu forti, or irritative fever with ſtrong pulſe.

When the contractile ſides of the heart and arteries perform a greater number of pulſations in a given time, but move through a much leſs area at each pulſation, whether theſe motions are occaſioned by defect of their natural ſtimuli, or by the defect of other irritative motions with which they are aſſociated, or from the inirritability of the arterial ſyſtem, that is, from a decreaſed quantity of ſenſorial power, another kind of fever ariſes; which may be termed, Typhus irritativus, or Febris irritativa pulſu debili, or irritative fever with weak pulſe. The former of theſe fevers is the ſynocha of noſologiſts, and the latter the typhus mitior, or nervous fever. In the former there appears to be an increaſe of ſenſorial power, in the latter a deficiency of it; which is ſhewn to be the immediate cauſe of ſtrength and weakneſs, as defined in Sect. XII. 1. 3.

It ſhould be added, that a temporary quantity of ſtrength or debility may be induced by the defect or exceſs of ſtimulus above what is natural; and that in the ſame fever *debility always exiſts during the*

cold

cold fit, though ſtrength does not always exiſt during the hot fit.

Theſe fevers are always connected with, and generally induced by, the diſordered irritative motions of the organs of ſenſe, or of the inteſtinal canal, or of the glandular ſyſtem, or of the abſorbent ſyſtem; and hence are always complicated with ſome or many of theſe diſordered motions, which are termed the ſymptoms of the fever, and which compoſe the great variety in theſe diſeaſes.

The irritative fevers both with ſtrong and with weak pulſe, as well as the ſenſitive fevers with ſtrong and with weak pulſe, which are to be deſcribed in the next ſection, are liable to periodical remiſſions, and then they take the name of intermittent fevers, and are diſtinguiſhed by the periodical times of their acceſs.

II. For the better illuſtration of the phenomena of irritative fevers we muſt refer the reader to the circumſtances of irritation explained in Sect. XII. and ſhall commence this intricate ſubject by ſpeaking of the quick pulſe, and proceed by conſidering many of the cauſes, which either ſeparately or in combination moſt frequently produce the cold fits of fevers.

1. If the arteries are dilated but to half their uſual diameters, though they contract twice as frequently in a given time, they will circulate only half their uſual quantity of blood: for as they are cylinders, the blood which they contain muſt be as the ſquares of their diameters. Hence when the pulſe becomes quicker and ſmaller in the ſame proportion, the heart and arteries act with leſs energy than in their natural ſtate. See Sect. XII. 1. 4.

That this quick ſmall pulſe is owing to want of irritability, appears, firſt, becauſe it attends other ſymptoms of want of irritability; and, ſecondly, becauſe on the application of a ſtimulus greater than

than uſual, it becomes ſlower and larger. Thus in cold fits of agues, in hyſteric palpitations of the heart, and when the body is much exhauſted by hæmorrhages, or by fatigue, as well as in nervous fevers, the pulſe becomes quick and ſmall; and, ſecondly, in all thoſe caſes if an increaſe of ſtimulus be added, by giving a little wine or opium; the quick ſmall pulſe becomes ſlower and larger, as any one may eaſily experience on himſelf, by counting his pulſe after drinking one or two glaſſes of wine, when he is faint from hunger or fatigue.

Now nothing can ſo ſtrongly evince that this quick ſmall pulſe is owing to defect of irritability, than that an additional ſtimulus, above what is natural, makes it become ſlower and larger immediately: for what is meant by a defect of irritability, but that the arteries and heart are not excited into their uſual exertions by their uſual quantity of ſtimulus? but if you increaſe the quantity of ſtimulus, and they immediately act with their uſual energy, this proves their previous want of their natural degree of irritability. Thus the trembling hands of drunkards in a morning become ſteady, and acquire ſtrength to perform their uſual offices, by the accuſtomed ſtimulus of a glaſs or two of brandy.

2. In ſleep and in apoplexy the pulſe becomes ſlower, which is not owing to defect of irritability, for it is at the ſame time larger; and thence the quantity of the circulation is rather increaſed than diminiſhed. In theſe caſes the organs of ſenſe are cloſed, and the voluntary power is ſuſpended, while the motions dependent on internal irritations, as thoſe of digeſtion and ſecretion, are carried on with more than their uſual vigour; which has led ſuperficial obſervers to confound theſe caſes with thoſe ariſing from want of irritability. Thus if you lift up the eyelid of an apoplectic patient, who is not

actually

actually dying, the iris will, as uſual, contract itſelf, as this motion is aſſociated with the ſtimulus of light; but it is not ſo in the laſt ſtages of nervous fevers, where the pupil of the eye continues expanded in the broad day-light: in the former caſe there is a want of voluntary power, in the latter a want of irritability.

Hence alſo thoſe conſtitutions which are deficient in quantity of irritability, and which poſſeſs too great ſenſibility, as during the pain of hunger, of nyſteric ſpaſms, or nervous headachs, are generally ſuppoſed to have too much irritability; and opium, which in its due doſe is a moſt powerful ſtimulant, is erroneouſly called a ſedative; becauſe by increaſing the irritative motions it decreaſes the pains ariſing from defect of them.

Why the pulſe ſhould become quicker both from an increaſe of irritation, as in the ſynocha irritativa, or irritative fever with ſtrong pulſe; and from the decreaſe of it, as in the typhus irritativus, or irritative fever with weak pulſe; ſeems paradoxical. The former circumſtance needs no illuſtration; ſince if the ſtimulus of the blood, or the irritability of the ſanguiferous ſyſtem be increaſed, and the ſtrength of the patient not diminiſhed, it is plain that the motions muſt be performed quicker and ſtronger.

In the latter circumſtance the weakneſs of the muſcular power of the heart is ſoon overbalanced by the elaſticity of the coats of the arteries, which they poſſeſs beſides a muſcular power of contraction; and hence the arteries are diſtended to leſs than their uſual diameters. The heart being thus ſtopped, when it is but half emptied, begins ſooner to dilate again; and the arteries being dilated to leſs than their uſual diameters, begin ſo much ſooner to contract themſelves; inſomuch, that in the laſt ſtages of fevers with weakneſs the frequency of pulſation

pulsation of the heart and arteries becomes doubled; which, however, is never the case in fevers with strength, in which they seldom exceed 118 or 120 pulsations in a minute. It must be added, that in these cases, while the pulse is very small and very quick, the heart often feels large, and labouring to one's hand; which coincides with the above explanation, shewing that it does not completely empty itself.

3. In cases however of debility from paucity of blood, as in animals which are bleeding to death in the slaughter-house, the quick pulsations of the heart and arteries may be owing to their not being distended to more than half their usual diastole; and in consequence they must contract sooner, or more frequently, in a given time. As weak people are liable to a deficient quantity of blood, this cause may occasionally contribute to quicken the pulse in fevers with debility, which may be known by applying one's hand upon the heart as above; but the principal cause I suppose to consist in the diminution of sensorial power. When a muscle contains, or is supplied with but little sensorial power, its contraction soon ceases, and in consequence may soon recur, as is seen in the trembling hands of people weakened by age or by drunkenness. See Sect. XII. 1. 4. XII. 3. 4.

It may nevertheless frequently happen, that both the deficiency of stimulus, as where the quantity of blood is lessened (as described in No. 4. of this section), and the deficiency of sensorial power, as in those of the temperament of inirritability, described in Sect. XXXI. occur at the same time; which will thus add to the quickness of the pulse and to the danger of the disease.

III. 1. A certain degree of heat is necessary to muscular motion, and is, in consequence, essential to life. This is observed in those animals and insects which

which paſs the cold ſeaſon in a torpid ſtate, and which revive on being warmed by the fire. This neceſſary ſtimulus of heat has two ſources; one from the fluid atmoſphere of heat, in which all things are immerſed, and the other from the internal combinations of the particles, which form the various fluids, which are produced in the extenſive ſyſtems of the glands. When either the external heat, which ſurrounds us, or the internal production of it, becomes leſſened to a certain degree, the pain of cold is perceived.

This pain of cold is experienced moſt ſenſibly by our teeth, when ice is held in the mouth; or by our whole ſyſtem after having been previouſly accuſtomed to much warmth. It is probable, that this pain does not ariſe from the mechanical or chemical effects of a deficiency of heat; but that, like the organs of ſenſe by which we perceive hunger and thirſt, this ſenſe of heat ſuffers pain, when the ſtimulus of its object is wanting to excite the irritative motions of the organ; that is, when the ſenſorial power becomes too much accumulated in the quieſcent fibres. See Sect. XII. 5. 3. For as the periſtaltic motions of the ſtomach are leſſened, when the pain of hunger is great, ſo the action of the cutaneous capillaries are leſſened during the pain of cold; as appears by the paleneſs of the ſkin, as explained in Sect. XIV. 6. on the production of ideas.

The pain in the ſmall of the back and forehead in the cold fits of the ague, in nervous hemicrania, and in hyſteric paroxyſms, when all the irritative motions are much impaired, ſeems to ariſe from this cauſe; the veſſels of theſe membranes or muſcles become torpid by their irritative aſſociations with other parts of the body, and thence produce leſs of their accuſtomed ſecretions, and in conſequence leſs heat is evolved, and they experience the pain of cold

cold; which coldneſs may often be felt by the hand applied upon the affected part.

2. The importance of a greater or leſs deduction of heat from the ſyſtem will be more eaſy to comprehend, if we firſt conſider the great expenſe of ſenſorial power uſed in carrying on the vital motions; that is, which circulates, abſorbs, ſecretes, aerates, and elaborates the whole maſs of fluids with unceaſing aſſiduity. The ſenſorial power, or ſpirit of animation, uſed in giving perpetual and ſtrong motion to the heart, which overcomes the elaſticity and vis inertiæ of the whole arterial ſyſtem; next the expenſe of ſenſorial power in moving with great force and velocity the innumerable trunks and ramifications of the arterial ſyſtem; the expenſe of ſenſorial power in circulating the whole maſs of blood through the long and intricate intortions of the very fine veſſels, which compoſe the glands and capillaries; then the expenſe of ſenſorial power in the exertions of the abſorbent extremities of all the lacteals, and of all the lymphatics, which open their mouths on the external ſurface of the ſkin, and on the internal ſurfaces of every cell or interſtice of the body; then the expenſe of ſenſorial power in the venous abſorption, by which the blood is received from the capillary veſſels, or glands, where the arterial power ceaſes, and is drank up, and returned to the heart; next the expenſe of ſenſorial power uſed by the muſcles of reſpiration in their office of perpetually expanding the bronchia, or air-veſſels, of the lungs; and laſtly in the unceaſing periſtaltic motions of the ſtomach and whole ſyſtem of inteſtines, and in all the ſecretions of bile, gaſtric juice, mucus, perſpirable matter, and the various excretions from the ſyſtem. If we conſider the ceaſeleſs expenſe of ſenſorial power thus perpetually employed, it will appear to be much greater in a day than all the voluntary exertions of our muſcles

muſcles and organs of ſenſe conſume in a week; and all this without any ſenſible fatigue! Now, if but a part of theſe vital motions are impeded, or totally ſtopped but for a ſhort time, we gain an idea, that there muſt be a great accumulation of ſenſorial power; as its production in theſe organs, which are ſubject to perpetual activity, is continued during their quieſcence, and is in conſequence accumulated.

While, on the contrary, where thoſe vital organs act too forcibly by increaſe of ſtimulus without a proportionally-increaſed production of ſenſorial power in the brain, it is evident, that a great deficiency of action, that is torpor, muſt ſoon follow, as in fevers; whereas the locomotive muſcles, which act only by intervals, are neither liable to ſo great accumulation of ſenſorial power during their times of inactivity, nor to ſo great an exhauſtion of it during their times of action.

Thus, on going into a very cold bath, ſuppoſe at 33 degrees of heat on Fahrenheit's ſcale, the action of the ſubcutaneous capillaries, or glands, and of the mouths of the cutaneous abſorbents is diminiſhed, or ceaſes for a time. Hence leſs or no blood paſſes theſe capillaries, and paleneſs ſucceeds. But ſoon after emerging from the bath, a more florid colour and a greater degree of heat is generated on the ſkin than was poſſeſſed before immerſion; for the capillary glands, after this quieſcent ſtate, occaſioned by the want of ſtimulus, become more irritable than uſual to their natural ſtimuli, owing to the accumulation of ſenſorial power, and hence a greater quantity of blood is tranſmitted through them, and a greater ſecretion of perſpirable matter; and, in conſequence, a greater degree of heat ſucceeds. During the continuance in cold water the breath is cold, and the act of reſpiration quick and laborious; which have generally been aſcribed

to

to the obſtruction of the circulating fluid by a ſpaſm of the cutaneous veſſels, and by a conſequent accumulation of blood in the lungs, occaſioned by the preſſure as well as by the coldneſs of the water. This is not a ſatisfactory account of this curious phænomenon, ſince at this time the whole circulation is leſs, as appears from the ſmallneſs of the pulſe and coldneſs of the breath; which ſhew that leſs blood paſſes through the lungs in a given time; the ſame laborious breathing immediately occurs when the paleneſs of the ſkin is produced by fear, where no external cold or preſſure are applied.

The minute veſſels of the bronchia, through which the blood paſſes from the arterial to the venal ſyſtem, and which correſpond with the cutaneous capillaries, have frequently been expoſed to cold air, and become quieſcent along with thoſe of the ſkin; and hence their motions are ſo aſſociated together, that when one is affected either with quieſcence or exertion, the other ſympathizes with it, according to the laws of irritative aſſociation. See Sect. XXVII. 1. on hæmorrhages.

Beſides the quieſcence of the minute veſſels of the lungs, there are many other ſyſtems of veſſels which become torpid from their irritative aſſociations with thoſe of the ſkin, as the abſorbents of the bladder and inteſtines; whence an evacuation of pale urine occurs, when the naked ſkin is expoſed only to the coldneſs of the atmoſphere; and ſprinkling the naked body with cold water is known to remove even pertinacious conſtipation of the bowels. From the quieſcence of ſuch extenſive ſyſtems of veſſels as the glands and capillaries of the ſkin, and the minute veſſels of the lungs, with their various abſorbent ſeries of veſſels, a great accumulation of ſenſorial powers is occaſioned; part of which is again expended in the increaſed exertion of all theſe veſſels, with an univerſal glow of heat

heat in conſequence of this exertion, and the remainder of it adds vigour to both the vital and voluntary exertions of the whole day.

If the activity of the ſubcutaneous veſſels, and of thoſe with which their actions are aſſociated, was too great before cold immerſion, as in the hot days of ſummer, and by that means the ſenſorial power was previouſly diminiſhed, we ſee the cauſe why the cold bath gives ſuch preſent ſtrength; namely, by ſtopping the unneceſſary activity of the ſubcutaneous veſſels, and thus preventing the too great exhauſtion of ſenſorial power; which, in metaphorical language, has been called *bracing* the ſyſtem: which is, however, a mechanical term, only applicable to drums, or muſical ſtrings: as on the contrary the word *relaxation*, when applied to living animal bodies, can only mean too ſmall a quantity of ſtimulus, or too ſmall a quantity of ſenſorial power: as explained in Sect. XII. 1.

3. This experiment of cold bathing preſents us with a ſimple fever-fit; for the pulſe is weak, ſmall, and quick during the cold immerſion; and becomes ſtrong, full, and quick during the ſubſequent glow of heat; till in a few minutes theſe ſymptoms ſubſide, and the temporary fever ceaſes.

In thoſe conſtitutions where the degree of inirritability, or of debility, is greater than natural, the coldneſs and paleneſs of the ſkin with the quick and weak pulſe continue a long time after the patient leaves the bath; and the ſubſequent heat approaches by unequal fluſhings, and he feels himſelf diſordered for many hours. Hence the bathing in a cold ſpring of water, where the heat is but forty-eight degrees on Fahrenheit's thermometer, much diſagrees with thoſe of weak or inirritable habits of body; who poſſeſs ſo little ſenſorial power, that they cannot without injury bear to have it diminiſhed even for a ſhort time; but who can nevertheleſs bear

bear the more temperate coldneſs of Buxton bath, which is about eighty degrees of heat, and which ſtrengthens them, and makes them by habit leſs liable to great quieſcence from ſmall variations of cold, and thence leſs liable to be diſordered by the unavoidable accidents of life. Hence it appears, why people of theſe inirritable conſtitutions, which is another expreſſion for ſenſorial deficiency, are often much injured by bathing in a cold ſpring of water; and why they ſhould continue but a very ſhort time in baths, which are colder than their bodies; and ſhould gradually increaſe both the degree of coldneſs of the water, and the time of their continuance in it, if they would obtain ſalutary effects from cold immerſions. See Sect. XII. 2. 1.

On the other hand, in all caſes where the heat of the external ſurface of the body, or of the internal ſurface of the lungs, is greater than natural, the uſe of expoſure to cool air may be deduced. In fever-fits attended with ſtrength, that is with great quantity of ſenſorial power, it removes the additional ſtimulus of heat from the ſurfaces abovementioned, and thus prevents their exceſs of uſeleſs motion; and in fever-fits attended with debility, that is with a deficiency of the quantity of ſenſorial power, it prevents the great and dangerous waſte of ſenſorial power expended in the unneceſſary increaſe of the actions of the glands and capillaries of the ſkin and lungs.

4. In the ſame manner, when any one is long expoſed to very cold air, a quieſcence is produced of the cutaneous and pulmonary capillaries and abſorbents, owing to the deficiency of their uſual ſtimulus of heat; and this quieſcence of ſo great a quantity of veſſels affects, by irritative aſſociation, the whole abſorbent and glandular ſyſtem, which becomes in a greater or leſs degree quieſcent, and a cold fit of fever is produced.

If

If the deficiency of the ſtimulus of heat is very great, the quieſcence becomes ſo general as to extinguiſh life, as in thoſe who are frozen to death.

If the deficiency of heat be in leſs degree, but yet ſo great as in ſome meaſure to diſorder the ſyſtem, and ſhould occur the ſucceeding day, it will induce a greater degree of quieſcence than before, from its acting in concurrence with the period of the diurnal circle of actions, explained in Sect. XXXVI. Hence from a ſmall beginning a greater and greater degree of quieſcence may be induced, till a complete fever-fit is formed; and which will continue to recur at the periods by which it was produced. See Sect. XVII. 3. 6.

If the degree of quieſcence occaſioned by defect of the ſtimulus of heat be very great, it will recur a ſecond time by a ſlighter cauſe, than that which firſt induced it. If the cauſe, which induces the ſecond fit of quieſcence, recurs the ſucceeding day, the quotidian fever is produced; if not till the alternate day, the tertian fever; and if not till after ſeventy-two hours from the firſt fit of quieſcence, the quartan fever is formed. This laſt kind of fever recurs leſs frequently than the other, as it is a diſeaſe only of thoſe of the temperament of aſſociability, as mentioned in Sect. XXXI.; for in other conſtitutions the capability of forming a habit ceaſes, before the new cauſe of quieſcence is again applied, if that does not occur ſooner than in ſeventy-two hours.

And hence thoſe fevers, whoſe cauſe is from cold air of the night or morning, are more liable to obſerve the ſolar day in their periods; while thoſe from other cauſes frequently obſerve the lunar day in their periods, their paroxyſms returning near an hour later every day, as explained in Sect. XXXVI.

IV. Another frequent cauſe of the cold fits of fever is the defect of the ſtimulus of diſtention.

The whole arterial ſyſtem would appear, by the experiments of Haller, to be irritable by no other ſtimulus, and the motions of the heart and alimentary canal are certainly in ſome meaſure dependant on the ſame cauſe. See Sect. XIV. 7. Hence there can be no wonder, that the diminution of diſtention ſhould frequently induce the quieſcence, which conſtitutes the beginning of fever-fits.

Monſieur Leiutaud has judiciouſly mentioned the deficiency of the quantity of blood amongſt the cauſes of diſeaſes, which he ſays is frequently evident in diſſections: fevers are hence brought on by great hæmorrhages, diarrhœas, or other evacuations; or from the continued uſe of diet, which contains but little nouriſhment; or from the exhauſtion occaſioned by violent fatigue, or by thoſe chronic diſeaſes in which the digeſtion is much impaired; as where the ſtomach has been long affected with the gout or ſchirrus; or in the paralyſis of the liver, as deſcribed in Sect. XXX. Hence a paroxyſm of gout is liable to recur on bleeding or purging; as the torpor of ſome viſcus, which precedes the inflammation of the foot, is thus induced by the want of the ſtimulus of diſtention. And hence the extremities of the body, as the noſe and fingers, are more liable to become cold, when we have long abſtained from food; and hence the pulſe is increaſed both in ſtrength and velocity above the natural ſtandard after a full meal by the ſtimulus of diſtention.

However, this ſtimulus of diſtention, like the ſtimulus of heat above deſcribed, though it contributes much to the due action not only of the heart, arteries, and alimentary canal, but ſeems neceſſary to the proper ſecretion of all the various glands; yet perhaps it is not the ſole cauſe of any of theſe numerous motions: for as the lacteals, cutaneous abſorbents, and the various glands appear to be

ſtimulated

ſtimulated into action by the peculiar pungency of the fluids they abſorb, ſo in the inteſtinal canal the pungency of the digeſting aliment, or the acrimony of the fæces, ſeem to contribute, as well as their bulk, to promote the periſtaltic motions; and in the arterial ſyſtem, the momentum of the particles of the circulating blood, and their acrimony, ſtimulate the arteries, as well as the diſtention occaſioned by it. Where the pulſe is ſmall this defect of diſtenſion is preſent, and contributes much to produce the febris irritativa pulſu debili, or irritative fever with weak pulſe, called by modern writers nervous fever, as a prediſponent cauſe. See Sect. XII. 1. 4. Might not the transfuſion of blood, ſuppoſe of four ounces daily from a ſtrong man, or other healthful animal, as a ſheep or an aſs, be uſed in the early ſtate of nervous or putrid fevers with great proſpect of ſucceſs?

V. The defect of the momentum of the particles of the circulating blood is another cauſe of the quieſcence, with which the cold fits of fever commence. This ſtimulus of the momentum of the progreſſive particles of the blood does not act over the whole body like thoſe of heat and diſtention above deſcribed, but is confined to the arterial ſyſtem; and differs from the ſtimulus of the diſtention of the blood, as much as the vibration of the air does from the currents of it. Thus are the different organs of our bodies ſtimulated by four different mechanic properties of the external world: the ſenſe of touch by the preſſure of ſolid bodies ſo as to diſtinguiſh their figure; the muſcular ſyſtem by the diſtention, which they occaſion; the internal ſurface of the arteries, by the momentum of their moving particles; and the auditory nerves, by the vibration of them: and theſe four mechanic properties are as different from each other as the

various chemical ones, which are adapted to the numerous glands, and to the other organs of ſenſe.

2. The momentum of the progreſſive particles of blood is compounded of their velocity and their quantity of matter: hence whatever circumſtances diminiſh either of theſe without proportionally increaſing the other, and without ſuperadding either of the general ſtimuli of heat or diſtention, will tend to produce a quieſcence of the arterial ſyſtem, and from thence of all the other irritative motions, which are connected with it.

Hence in all thoſe conſtitutions or diſeaſes where the blood contains a greater proportion of ſerum, which is the lighteſt part of its compoſition, the pulſations of the arteries are weaker, as in nervous fevers, chloroſis, and hyſteric complaints; for in theſe caſes the momentum of the progreſſive particles of blood is leſs: and hence, where the denſer parts of its compoſition abound, as the red part of it, or the coagulable lymph, the arterial pulſations are ſtronger; as in thoſe of robuſt health, and in inflammatory diſeaſes.

That this ſtimulus of the momentum of the particles of the circulating fluid is of the greateſt conſequence to the arterial action, appears from the experiment of injecting air into the blood veſſels, which ſeems to deſtroy animal life from the want of this ſtimulus of momentum; for the diſtention of the arteries is not diminiſhed by it, it poſſeſſes no corroſive acrimony, and is leſs liable to repaſs the valves than the blood itſelf; ſince air-valves in all machinery require much leſs accuracy of conſtruction than thoſe which are oppoſed to water.

3. One method of increaſing the velocity of the blood, and in conſequence the momentum of its particles, is by the exerciſe of the body, or by the friction of its ſurface: ſo, on the contrary, too great indolence contributes to decreaſe this ſtimulus

of

of the momentum of the particles of the circulating blood, and thus tends to induce quieſcence: as is ſeen in hyſteric caſes, and chloroſis, and the other diſeaſes of ſedentary people.

4. The velocity of the particles of the blood in certain circumſtances is increaſed by veneſection, which, by removing a part of it, diminiſhes the reſiſtance to the motion of the other part, and hence the momentum of the particles of it is increaſed. This may be eaſily underſtood by conſidering it in the extreme, ſince, if the reſiſtance was greatly increaſed, ſo as to overcome the propelling power, there could be no velocity, and in conſequence no momentum at all. From this circumſtance ariſes that curious phænomenon, the truth of which I have been more than once witneſs to, that veneſection will often inſtantaneouſly relieve thoſe nervous pains, which attend the cold periods of hyſteric, aſthmatic, or epileptic diſeaſes; and that even where large doſes of opium have been in vain exhibited. In theſe caſes the pulſe becomes ſtronger after the bleeding, and the extremities regain their natural warmth; and an opiate then given acts with much more certain effect.

VI. There is another cauſe, which ſeems occaſionally to induce quieſcence into ſome part of our ſyſtem, I mean the influence of the ſun and moon; the attraction of theſe luminaries, by decreaſing the gravity of the particles of the blood, cannot affect their momentum, as their vis inertiæ remains the ſame; but it may nevertheleſs produce ſome chemical change in them, becauſe whatever affects the general attractions of the particles of matter may be ſuppoſed from analogy to affect their ſpecific attractions or affinities: and thus the ſtimulus of the particles of blood may be diminiſhed, though not their momentum. As the tides of the ſea obey the ſouthing and northing of the moon

moon (allowing for the time neceſſary for their motion, and the obſtructions of the ſhores), it is probable, that there are alſo atmoſpheric tides on both ſides of the earth, which to the inhabitants of another planet might ſo deflect the light as to reſemble the ring of Saturn. Now as theſe tides of water, or of air, are raiſed by the diminution of their gravity, it follows, that their preſſure on the ſurface of the earth is no greater than the preſſure of the other parts of the ocean, or of the atmoſphere, where no ſuch tides exiſt; and therefore that they cannot affect the mercury in the barometer. In the ſame manner, the gravity in all other terreſtrial bodies is diminiſhed at the times of the ſouthing and northing of the moon, and that in a greater degree when this coincides with the ſouthing and northing of the ſun, and this in a ſtill greater degree about the times of the equinoxes. This decreaſe of the gravity of all bodies during the time the moon paſſes our zenith or nadir might poſſibly be ſhewn by the ſlower vibrations of a pendulum, compared with a ſpring clock, or with aſtronomical obſervation. Since a pendulum of a certain length moves ſlower at the line than near the poles, becauſe the gravity being diminiſhed and the vis inertiæ continuing the ſame, the motive power is leſs, but the reſiſtance to be overcome continues the ſame. The combined powers of the lunar and ſolar attraction is eſtimated by Sir Iſaac Newton not to exceed one 7,868,850th part of the power of gravitation, which ſeems indeed but a ſmall circumſtance to produce any conſiderable effect on the weight of ſublunary bodies, and yet this is ſufficient to raiſe the tides at the equator above ten feet high; and if it be conſidered, what ſmall impulſes of other bodies produce their effects on the organs of ſenſe adapted to the perception of them, as of vibration on the audi-

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tory nerves, we ſhall ceaſe to be ſurpriſed, that ſo minute a diminution in the gravity of the particles of blood ſhould ſo far affect their chemical changes, or their ſtimulating quality, as, joined with other cauſes, ſometimes to produce the beginnings of diſeaſes.

Add to this, that if the lunar influence produces a very ſmall degree of quieſcence at firſt, and if that recurs at certain periods even with leſs power to produce quieſcence than at firſt, yet the quieſcence will daily increaſe by the acquired habit acting at the ſame time, till at length ſo great a degree of quieſcence is induced as to produce phrenſy, canine madneſs, epilepſy, hyſteric pains or cold fits of fever, inſtances of many of which are to be found in Dr. Mead's work on this ſubject. The ſolar influence alſo appears daily in ſeveral diſeaſes; but as darkneſs, ſilence, ſleep, and our periodical meals mark the parts of the ſolar circle of actions, it is ſometimes dubious to which of theſe the periodical returns of theſe diſeaſes are to be aſcribed.

As far as I have been able to obſerve, the periods of inflammatory diſeaſes obſerve the ſolar day; as the gout and rheumatiſm have their greateſt quieſcence about noon and midnight, and their exacerbations ſome hours after; as they have more frequently their immediate cauſe from cold air, inanition, or fatigue, than from the effect of lunations: whilſt the cold fits of hyſteric patients, and thoſe in nervous fevers, more frequently occur twice a day, later by near half an hour each time, according to the lunar day; whilſt ſome fits of intermittents, which are undiſturbed by medicines, return at regular ſolar periods, and others at lunar ones; which may, probably, be owing to the difference of the periods of thoſe external circumſtances

cumſtances of cold, inanition, or lunation, which immediately cauſed them.

We muſt, however, obſerve, that the periods of quieſcence and exacerbation in diſeaſes do not always commence at the times of the ſyzygies or quadratures of the moon and ſun, or at the times of their paſſing the zenith or nadir; but as it is probable, that the ſtimulus of the particles of the circumfluent blood is gradually diminiſhed from the time of the quadratures to that of the ſyzygies, the quieſcence may commence at any hour, when co-operating with other cauſes of quieſcence, it becomes great enough to produce a diſeaſe; afterwards it will continue to recur at the ſame periods of the lunar or ſolar influence; the ſame cauſe operating conjointly with the acquired habit, that is with the catenation of this new motion with the diſſevered links of the lunar or ſolar circles of animal action.

In this manner the periods of menſtruation obey the lunar month with great exactneſs in healthy patients (and perhaps the venereal orgaſm in brute animals does the ſame), yet theſe periods do not commence either at the ſyzygies or quadratures of the lunations, but at whatever time of the lunar periods they begin, they obſerve the ſame in their returns till ſome greater cauſe diſturbs them.

Hence, though the beſt way to calculate the time of the expected returns of the paroxyſms of periodical diſeaſes is to count the number of hours between the commencement of the two preceding fits, yet the following obſervations may be worth attending to, when we endeavour to prevent the returns of maniacal or epileptic diſeaſes; whoſe periods (at the beginning of them eſpecially) frequently obſerve the ſyzygies of the moon and ſun, and particularly about the equinox.

The greateſt of the two tides happening in every revolution

revolution of the moon, is that when the moon approaches neareſt to the zenith or nadir; for this reaſon, while the ſun is in the northern ſigns, that is during the vernal and ſummer months, the greater of the two diurnal tides in our latitude is that, when the moon is above the horizon; and when the ſun is in the ſouthern ſigns, or during the autumnal and winter months, the greater tide is that, which ariſes when the moon is below the horizon: and as the ſun approaches ſomewhat nearer the earth in winter than in ſummer, the greateſt equinoctial tides are obſerved to be a little before the vernal equinox, and a little after the autumnal one.

Do not the cold periods of lunar diſeaſes commence a few hours before the ſouthing of the moon during the vernal and ſummer months, and before the northing of the moon during the autumnal and winter months? Do not palſies and apoplexies, which occur about the equinoxes, happen a few days before the vernal equinoctial lunation, and after the autumnal one? Are not the periods of thoſe diurnal diſeaſes more obſtinate, that commence many hours before the ſouthing or northing of the moon, than of thoſe which commence at thoſe times? Are not thoſe palſies and apoplexies more dangerous which commence many days before the ſyzygies of the moon, than thoſe which happen at thoſe times? See Sect. XXXVI. on the periods of diſeaſes.

VII. Another very frequent cauſe of the cold fit of fever is the quieſcence of ſome of thoſe large congeries of glands, which compoſe the liver, ſpleen, or pancreas; one or more of which are frequently ſo enlarged in the autumnal intermittents as to be perceptible to the touch externally, and are called by the vulgar ague-cakes. As theſe glands are ſtimulated into action by the ſpecific pungency

pungency of the fluids, which they abſorb, the general cauſe of their quieſcence ſeems to be the too great inſipidity of the fluids of the body, co-operating perhaps at the ſame time with other general cauſes of quieſcence.

Hence, in marſhy countries at cold ſeaſons, which have ſucceeded hot ones, and amongſt thoſe, who have lived on innutritious and unſtimulating diet, theſe agues are moſt frequent. The enlargement of theſe quieſcent viſcera, and the ſwelling of the præcordia in many other fevers, is, moſt probably, owing to the ſame cauſe; which may conſiſt in a general deficiency of the production of ſenſorial power, as well as in the diminiſhed ſtimulation of the fluids; and when the quieſcence of ſo great a number of glands, as conſtitute one of thoſe large viſcera, commences, all the other irritative motions are affected by their connexion with it, and the cold fit of fever is produced.

VIII. There are many other cauſes, which produce quieſcence of ſome part of the animal ſyſtem, as fatigue, hunger, thirſt, bad diet, diſappointed love, unwholeſome air, exhauſtion from evacuations, and many others; but the laſt cauſe, that we ſhall mention, as frequently productive of cold fits of fever, is fear or anxiety of mind. The pains, which we are firſt and moſt generally acquainted with, have been produced by defect of ſome ſtimulus; thus, ſoon after our nativity we become acquainted with the pain from the coldneſs of the air, from the want of reſpiration, and from the want of food. Now all theſe pains occaſioned by defect of ſtimulus are attended with quieſcence of the organ, and at the ſame time with a greater or leſs degree of quieſcence of other parts of the ſyſtem: thus, if we even endure the pain of hunger ſo as to miſs one meal inſtead of our daily habit of repletion, not only the periſtaltic motions of the ſtomach and bowels are diminiſhed

miniſhed, but we are more liable to coldneſs of our extremities, as of our noſes, and ears, and feet, than at other times.

Now, as fear is originally excited by our having experienced pain, and is itſelf a painful affection, the ſame quieſcence of other fibrous motions accompany it, as have been moſt frequently connected with this kind of pain, as explained in Sect. XVI. 8. 1. as the coldneſs and paleneſs of the ſkin, trembling, difficult reſpiration, indigeſtion, and other ſymptoms, which contribute to form the cold fit of fevers. Anxiety is fear continued through a longer time, and, by producing chronical torpor of the ſyſtem, extinguiſhes life ſlowly, by what is commonly termed a broken heart.

IX. 1. We now ſtep forwards to conſider the other ſymptoms in conſequence of the quieſcence which begins the fits of fever. If by any of the circumſtances before deſcribed, or by two or more of them acting at the ſame time, a great degree of quieſcence is induced on any conſiderable part of the circle of irritative motions, the whole claſs of them is more or leſs diſturbed by their irritative aſſociations. If this torpor be occaſioned by a deficient ſupply of ſenſorial power, and happens to any of thoſe parts of the ſyſtem, which are accuſtomed to perpetual activity, as the vital motions, the torpor increaſes rapidly, becauſe of the great expenditure of ſenſorial power by the inceſſant activity of thoſe parts of the ſyſtem, as ſhewn in No. 3. 2. of this Section. Hence a deficiency of all the ſecretions ſucceeds, and as animal heat is produced in proportion to the quantity of thoſe ſecretions, the coldneſs of the ſkin is the firſt circumſtance, which is attended to. Dr. Martin aſſerts, that ſome parts of his body were warmer than natural in the cold fit of fever; but it is certain, that thoſe which are uncovered, as the fingers, and noſe, and ears, are much colder to the touch, and paler in appearance. It is poſſi-

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ble, that his experiments were made at the beginning of the ſubſequent hot fits; which commence with partial diſtributions of heat, owing to ſome parts of the body regaining their natural irritability ſooner than others.

From the quieſcence of the anaſtomoſing capillaries a paleneſs of the ſkin ſucceeds, and a leſs ſecretion of the perſpirable matter; from the quieſcence of the pulmonary capillaries a difficulty of reſpiration ariſes; and from the quieſcence of the other glands leſs bile, leſs gaſtric and pancreatic juice, are ſecreted into the ſtomach and inteſtines, and leſs mucus and ſaliva are poured into the mouth; whence ariſes the dry tongue, coſtiveneſs, dry ulcers, and paucity of urine. From the quieſcence of the abſorbent ſyſtem ariſes the great thirſt, as leſs moiſture is abſorbed from the atmoſphere. The abſorption from the atmoſphere was obſerved by Dr. Lyſter to amount to eighteen ounces in one night, above what he had at the ſame time inſenſibly perſpired. See Langriſh. On the ſame account the urine is pale, though in ſmall quantity, for the thinner part is not abſorbed from it; and when repeated ague fits continue long, the legs ſwell from the diminiſhed abſorption of the cellular abſorbents.

From the quieſcence of the inteſtinal canal a loſs of appetite and flatulencies proceed. From the partial quieſcence of the glandular viſcera a ſwelling and tenſion about the præcordia becomes ſenſible to the touch; which is occaſioned by the delay of the fluids from the defect of venous or lymphatic abſorption. The pain of the forehead, and of the limbs, and of the ſmall of the back, ariſes from the quieſcence of the membranous faſcia, or muſcles of thoſe parts, in the ſame manner as the ſkin becomes painful, when the veſſels, of which it is compoſed, become quieſcent from cold

cold. The trembling in conſequence of the pain of coldneſs, the reſtleſſneſs, and the yawning, and ſtretching of the limbs, together with the ſhuddering, or rigours, are convulſive motions; and will be explained amongſt the diſeaſes of volition; Sect. XXXIV.

Sickneſs and vomiting is a frequent ſymptom in the beginnings of fever-fits, the muſcular fibres of the ſtomach ſhare the general torpor and debility of the ſyſtem; their motions become firſt leſſened, and then ſtop, and then become retrograde; for the act of vomiting, like the globus hyſtericus and the borborigmi of hypochondriaſis, is always a ſymptom of debility, either from want of ſtimulus, as in hunger; or from want of ſenſorial power, as after intoxication; or from ſympathy with ſome other torpid irritative motions, as in the cold fits of ague. See Sect. XII. 5. 5. XXIX. 11. and XXXV. 1. 3. where this act of vomiting is further explained.

The ſmall pulſe, which is ſaid by ſome writers to be ſlow at the commencement of ague-fits, and which is frequently trembling and intermittent, is owing to the quieſcence of the heart and arterial ſyſtem, and to the reſiſtance oppoſed to the circulating fluid from the inactivity of all the glands and capillaries. The great weakneſs and inability to voluntary motions, with the inſenſibility of the extremities, are owing to the general quieſcence of the whole moving ſyſtem; or perhaps, ſimply to the deficient production of ſenſorial power.

If all theſe ſymptoms are further increaſed, the quieſcence of all the muſcles, including the heart and arteries, becomes complete, and death enſues. This is, moſt probably, the caſe of thoſe who are ſtarved to death with cold, and of thoſe who are ſaid to die in Holland from long ſkaiting on their frozen canals.

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2. As ſoon as this general quieſcence of the ſyſtem ceaſes, either by the diminution of the cauſe, or by the accumulation of ſenſorial power, (as in ſyncope, Sect. XII. 7. 1.) which is the natural conſequence of previous quieſcence, the hot fit commences. Every gland of the body is now ſtimulated into ſtronger action than is natural, as its irritability is increaſed by accumulation of ſenſorial power during its late quieſcence, a ſuperabundance of all the ſecretions is produced, and an increaſe of heat in conſequence of the increaſe of theſe ſecretions. The ſkin becomes red, and the perſpiration great, owing to the increaſed action of the capillaries during the hot part of the paroxyſm. The ſecretion of perſpirable matter is perhaps greater during the hot fit than in the ſweating fit which follows; but as the abſorption of it alſo is greater, it does not ſtand on the ſkin in viſible drops: add to this, that the evaporation of it is alſo greater, from the increaſed heat of the ſkin. But at the decline of the hot fit, as the mouths of the abſorbents of the ſkin are expoſed to the cooler air, or bed-clothes, theſe veſſels ſooner loſe their increaſed activity, and ceaſe to abſorb more than their natural quantity: but the ſecerning veſſels for ſome time longer, being kept warm by the circulating blood, continue to pour out an increaſed quantity of perſpirable matter, which now ſtands on the ſkin in large viſible drops; the exhalation of it alſo being leſſened by the greater coolneſs of the ſkin, as well as its abſorption by the diminiſhed action of the lymphatics. See Claſs I. 1. 2. 3.

The increaſed ſecretion of bile and of other fluids poured into the inteſtines frequently induce a purging at the decline of the hot fit; for as the external abſorbent veſſels have their mouths expoſed to the cold air, as above mentioned, they ceaſe to be excited into unnatural activity ſooner than

than the ſecretory veſſels, whoſe mouths are expoſed to the warmth of the blood: now, as the internal abſorbents ſympathize with the external ones, theſe alſo, which during the hot fit drank up the thinner part of the bile, or of other ſecreted fluids, loſe their increaſed activity before the gland loſes its increaſed activity, at the decline of the hot fit; and the looſe dejections are produced from the ſame cauſe, that the increaſed perſpiration ſtands on the ſurface of the ſkin, from the increaſed abſorption ceaſing ſooner than the increaſed ſecretion.

The urine during the cold fit is in ſmall quantity and pale, both from a deficiency of the ſecretion and a deficiency of the abſorption. During the hot fit it is in its uſual quantity, but very high-coloured and turbid, becauſe a greater quantity had been ſecreted by the increaſed action of the kidnies, and alſo a greater quantity of its more aqueous part had been abſorbed from it in the bladder by the increaſed action of the abſorbents; and laſtly, at the decline of the hot fit it is in large quantity and leſs coloured, or turbid, becauſe the abſorbent veſſels of the bladder, as obſerved above, loſe their increaſed action by ſympathy with the cutaneous ones ſooner than the ſecretory veſſels of the kidnies loſe their increaſed activity. Hence the quantity of the ſediment, and the colour of the urine, in fevers, depend much on the quantity ſecreted by the kidnies, and the quantity abſorbed from it again in the bladder: the kinds of ſediment, as the lateritious, purulent, mucous, or bloody ſediments, depend on other cauſes. It ſhould be obſerved, that if the ſweating be increaſed by the heat of the room, or of the bed-clothes, a paucity of turbid urine will continue to be produced, as the abſorbents of the bladder will have their activity increaſed by their ſympathy with the veſſels

veſſels of the ſkin, for the purpoſe of ſupplying the fluid expended in perſpiration.

The pulſe becomes ſtrong and full, owing to the increaſed irritability of the heart and arteries, from the accumulation of ſenſorial power during their quieſcence, and to the quickneſs of the return of the blood from the various glands and capillaries. This increaſed action of all the ſecretory veſſels does not occur very ſuddenly, nor univerſally at the ſame time. The heat ſeems to begin about the center, and to be diffuſed from thence irregularly to the other parts of the ſyſtem. This may be owing to the ſituation of the parts which firſt became quieſcent and cauſed the fever-fit, eſpecially when a hardneſs or tumour about the præcordia can be felt by the hand; and hence this part, in whatever viſcus it is ſeated, might be the firſt to regain its natural or increaſed irritability.

3. It muſt be here noted, that, by the increaſed quantity of heat, and of the impulſe of the blood at the commencement of the hot fit, a great increaſe of ſtimulus is induced, and is now added to the increaſed irritability of the ſyſtem, which was occaſioned by its previous quieſcence. This additional ſtimulus of heat and momentum of the blood augments the violence of the movements of the arterial and glandular ſyſtem in an increaſing ratio. Theſe violent exertions ſtill producing more heat and greater momentum of the moving fluids, till at length the ſenſorial power becomes waſted by this great ſtimulus beneath its uſual quantity, and prediſpoſes the ſyſtem to a ſecond cold fit.

At length all theſe unnatural exertions ſpontaneouſly ſubſide with the increaſed irritability that produced them; and which was itſelf produced by the preceding quieſcence, in the ſame manner as the eye, on coming from darkneſs into day-light, in a little time ceaſes to be dazzled and pained, and gradually

gradually recovers its natural degree of irritability.

4. But if the increaſe of irritability, and the conſequent increaſe of the ſtimulus of heat and momentum, produce more violent exertions than thoſe above deſcribed; great pain ariſes in ſome part of the moving ſyſtem, as in the membranes of the brain, pleura, or joints; and new motions of the veſſels are produced in conſequence of this pain, which are called inflammation; or delirium or ſtupor ariſes; as explained in Sect. XXI. and XXXIII.: for the immediate effect is the ſame, whether the great energy of the moving organs ariſes from an increaſe of ſtimulus or an increaſe of irritability; though in the former caſe the waſte of ſenſorial power leads to debility, and in the latter to health.

Recapitulation.

X. Thoſe muſcles, which are leſs frequently exerted, and whoſe actions are interrupted by ſleep, acquire leſs accumulation of ſenſorial power during their quieſcent ſtate, as the muſcles of locomotion. In theſe muſcles after great exertion, that is, after great exhauſtion of ſenſorial power, the pain of fatigue enſues; and during reſt there is a renovation of the natural quantity of ſenſorial power; but where the reſt, or quieſcence of the muſcle, is long continued, a quantity of ſenſorial power becomes accumulated beyond what is neceſſary; as appears by the uneaſineſs occaſioned by want of exerciſe; and which in young animals is one cauſe exciting them into action, as is ſeen in the play of puppies and kittens.

But when thoſe muſcles, which are habituated to perpetual actions, as thoſe of the ſtomach by the ſtimulus of food, thoſe of the veſſels of the ſkin by

the ſtimulus of heat, and thoſe which conſtitute the arteries and glands by the ſtimulus of the blood, become for a time quieſcent, from the want of their appropriated ſtimuli, or by their aſſociations with other quieſcent parts of the ſyſtem; a greater accumulation of ſenſorial power is acquired during their quieſcence, and a greater or quicker exhauſtion is produced during their increaſed action.

This accumulation of ſenſorial power from deficient action, if it happens to the ſtomach from want of food, occaſions the pain of hunger; if it happens to the veſſels of the ſkin from want of heat, it occaſions the pain of cold; and if to the arterial ſyſtem from the want of its adapted ſtimuli, many diſagreeable ſenſations are occaſioned, ſuch as are experienced in the cold fits of intermittent fevers, and are as various, as there are glands or membranes in the ſyſtem, and are generally termed univerſal uneaſineſs.

When the quieſcence of the arterial ſyſtem is not owing to defect of ſtimulus as above, but to the defective quantity of ſenſorial power, as in the commencement of nervous fever, or irritative fever with weak pulſe, a great torpor of this ſyſtem is quickly induced; becauſe both the irritation from the ſtimulus of the blood, and the aſſociation of the vaſcular motions with each other, continue to excite the arteries into action, and thence quickly exhauſt the ill-ſupplied vaſcular muſcles; for to reſt is death; and therefore thoſe vaſcular muſcles continue to proceed, though with feebler action, to the extreme of wearineſs or faintneſs; while nothing ſimilar to this affects the locomotive muſcles, whoſe actions are generally cauſed by volition, and not much ſubject either to irritation or to other kinds of aſſociations beſides the voluntary ones, except indeed when they are excited by the laſh of ſlavery.

In

In theſe vaſcular muſcles, which are ſubject to perpetual action, and thence liable to great accumulation of ſenſorial power during their quieſcence from want of ſtimulus, a great increaſe of activity occurs, either from the renewal of their accuſtomed ſtimulus, or even from much leſs quantities of ſtimulus than uſual. This increaſe of action conſtitutes the hot fit of fever, which is attended with various increaſed ſecretions, with great concomitant heat, and general uneaſineſs. The uneaſineſs attending this hot paroxyſm of fever, or fit of exertion, is very different from that, which attends the previous cold fit, or fit of quieſcence, and is frequently the cauſe of inflammation, as in pleuriſy, which is treated of in the next ſection.

A ſimilar effect occurs after the quieſcence of our organs of ſenſe; thoſe which are not ſubject to perpetual action, as the taſte and ſmell, are leſs liable to an exuberant accumulation of ſenſorial power after their having for a time been inactive; but the eye, which is in perpetual action during the day, becomes dazzled, and liable to inflammation after a temporary quieſcence.

Where the previous quieſcence has been owing to a defect of ſenſorial power, and not to a defect of ſtimulus, as in the irritative fever with weak pulſe, a ſimilar increaſe of activity of the arterial ſyſtem ſucceeds, either from the uſual ſtimulus of the blood, or from a ſtimulus leſs than uſual; but as there is in general in theſe caſes of fever with weak pulſe a deficiency of the quantity of the blood, the pulſe in the hot fit is weaker than in health, though it is ſtronger than in the cold fit, as explained in No. 2. of this ſection. But at the ſame time in thoſe fevers, where the defect of irritation is owing to the defect of the quantity of ſenſorial power, as well as to the defect of ſtimulus, another circumſtance occurs; which conſiſts in the partial diſtribution of it,

as appears in partial flushings, as of the face or bosom, while the extremities are cold; and in the increase of particular secretions, as of bile, saliva, insensible perspiration, with great heat of the skin, or with partial sweats, or diarrhœa.

There are also many uneasy sensations attending these increased actions, which, like those belonging to the hot fit of fever with strong pulse, are frequently followed by inflammation, as in scarlet fever; which inflammation is nevertheless accompanied with a pulse weaker, though quicker, than the pulse during the remission or intermission of the paroxysms, though stronger than that of the previous cold fit.

From hence I conclude, that both the cold and hot fits of fever are necessary consequences of the perpetual and incessant action of the arterial and glandular system since those muscular fibres, and those organs of sense, which are most frequently exerted, become necessarily most affected both with defect and accumulation of sensorial power: and that hence *fever-fits are not an effort of nature to relieve herself*, and that therefore they should always be prevented or diminished as much as possible, by any means which decrease the general or partial vascular actions, when they are greater, or by increasing them when they are less than in health, as described in Sect. XII. 6. 1.

Thus have I endeavoured to explain, and I hope to the satisfaction of the candid and patient reader, the principal symptoms or circumstances of fever without the introduction of the supernatural power of spasm. To the arguments in favour of the doctrine of spasm it may be sufficient to reply, that in the evolution of medical as well as of dramatic catastrophe,

Nec Deus interfit, nisi dignus vindice nodus inciderit.
Hor.

SECT.

SECT. XXXIII.

DISEASES OF SENSATION.

I. *Motions excited by ſenſation. Digeſtion. Generation. Pleaſure of exiſtence. Hypochondriaciſm.* 2. *Pain introduced. Senſitive fevers of two kinds.* 3. *Two ſenſorial powers exerted in ſenſitive fevers. Size of the blood. Nervous fevers diſtinguiſhed from putrid ones. The ſeptic and antiſeptic theory.* 4. *Two kinds of delirium.* 5. *Other animals are leſs liable to delirium, cannot receive our contagious diſeaſes, and are leſs liable to madneſs.* II. 1. *Senſitive motions generated.* 2. *Inflammation explained.* 3. *Its remote cauſes from exceſs of irritation, or of irritability, not from thoſe pains which are owing to defect of irritation. New veſſels produced, and much heat.* 4. *Purulent matter ſecreted.* 5. *Contagion explained.* 6. *Received but once.* 7. *If common matter be contagious?* 8. *Why ſome contagions are received but once.* 9. *Why others may be received frequently. Contagions of ſmall-pox and meaſles do not act at the ſame times. Two caſes of ſuch patients.* 10. *The blood from patients in the ſmall-pox will not infect others. Caſes of children thus inoculated. The variolous contagion is not received into the blood. It acts by ſenſitive aſſociation between the ſtomach and ſkin.* III. 1. *Abſorption of ſolids and fluids.* 2. *Art of healing ulcers.* 3. *Mortification attended with leſs pain in weak people.*

I. 1. AS many motions of the body are excited and continued by irritations, ſo others require, either conjunctly

conjunctly with theſe, or ſeparately, the pleaſurable or painful ſenſations, for the purpoſe of producing them with due energy. Amongſt theſe the buſineſs of digeſtion ſupplies us with an inſtance: if the food, which we ſwallow, is not attended with agreeable ſenſation, it digeſts leſs perfectly; and if very diſagreeable ſenſation accompanies it, ſuch as a nauſeous idea, or very diſguſtful taſte, the digeſtion becomes impeded; or retrograde motions of the ſtomach and œſophagus ſucceed, and the food is ejected.

The buſineſs of generation depends ſo much on agreeable ſenſation, that, where the object is diſguſtful, neither voluntary exertion nor irritation can effect the purpoſe; which is alſo liable to be interrupted by the pain of fear or baſhfulneſs.

Beſides the pleaſure, which attends the irritations produced by the objects of luſt and hunger, there ſeems to be a ſum of pleaſurable affection accompanying the various ſecretions of the numerous glands, which conſtitute the pleaſure of life, in contradiſtinction to the tædium vitæ. This quantity or ſum of pleaſurable affection ſeems to contribute to the due or energetic performance of the whole moveable ſyſtem, as well that of the heart and arteries, as of digeſtion and of abſorption; ſince without the due quantity of pleaſurable ſenſation, flatulency and hypochondriaciſm affect the inteſtines, and a languor ſeizes the arterial pulſations and ſecretions; as occurs in great and continued anxiety of the mind.

2. Beſides the febrile motions occaſioned by irritation, deſcribed in Sect. XXXII. and termed irritative fever, it frequently happens that pain is excited by the violence of the fibrous contractions; and other new motions are then ſuperadded, in conſequence of ſenſation, which we ſhall term febris ſenſitiva, or ſenſitive fever. It muſt be obſerved, that moſt irritative

ritative fevers begin with a decreaſed exertion of irritation, owing to defect of ſtimulus; but that on the contrary the ſenſitive fevers, or inflammations, generally begin with the increaſed exertion of ſenſation, as mentioned in Sect. XXXI. on temperaments: for though the cold fit, which introduces inflammation, commences with decreaſed irritation, yet the inflammation itſelf commences in the hot fit during the increaſe of ſenſation. Thus a common puſtule, or phlegmon, in a part of little ſenſibility does not excite an inflammatory fever; but if the ſtomach, inteſtines, or the tender ſubſtance beneath the nails, be injured, great ſenſation is produced, and the whole ſyſtem is thrown into that kind of exertion, which conſtitutes inflammation.

Theſe ſenſitive fevers, like the irritative ones, reſolve themſelves into thoſe with arterial ſtrength, and thoſe with arterial debility, that is, with exceſs or defect of ſenſorial power; theſe may be termed the febris ſenſitiva pulſu forti, ſenſitive fever with ſtrong pulſe, which is the ſynocha, or inflammatory fever; and the febris ſenſitiva pulſu debili, ſenſitive fever with weak pulſe, which is the typhus gravior, or putrid fever of ſome writers.

3. The inflammatory fevers, which are here termed ſenſitive fevers with ſtrong pulſe, are generally attended with ſome topical inflammation, as pleuriſy, peripneumony, or rheumatiſm, which diſtinguiſhes them from irritative fevers with ſtrong pulſe. The pulſe is ſtrong, quick, and full; for in this fever there is great irritation, as well as great ſenſation, employed in moving the arterial ſyſtem. The ſize, or coagulable lymph, which appears on the blood, is probably an increaſed ſecretion from the inflamed internal lining of the whole arterial ſyſtem, the thinner part being taken away by the increaſed abſorption of the inflamed lymphatics.

The

The ſenſitive fevers with weak pulſe, which are termed putrid or malignant fevers, are diſtinguiſhed from irritative fevers with weak pulſe, called nervous fevers, deſcribed in the laſt ſection, as the former conſiſt of inflammation joined with debility, and the latter of debility alone. Hence there is greater heat and more florid colour of the ſkin in the former, with petechiæ, or purple ſpots, and aphthæ, or ſloughs in the throat, and generally with previous contagion.

When animal matter dies, as a ſlough in the throat, or the mortified part of a carbuncle, if it be kept moiſt and warm, as during its adheſion to a living body, it will ſoon putrify. This, and the origin of contagion from putrid animal ſubſtances, ſeem to have given riſe to the ſeptic and antiſeptic theory of theſe fevers.

The matter in puſtules and ulcers is thus liable to become putrid, and to produce microſcopic animalcula; the urine, if too long retained, may alſo gain a putreſcent ſmell, as well as the alvine feces; but ſome writers have gone ſo far as to believe, that the blood itſelf in theſe fevers has ſmelt putrid, when drawn from the arm of the patient: but this ſeems not well founded; ſince a ſingle particle of putrid matter taken into the blood can produce fever, how can we conceive that the whole maſs could continue a minute in a putrid ſtate without deſtroying life? Add to this, that putrid animal ſubſtances give up air, as in gangrenes; and that hence if the blood was putrid, air ſhould be given out, which in the blood-veſſels is known to occaſion immediate death.

In theſe ſenſitive fevers with ſtrong pulſe (or inflammations) there are two ſenſorial faculties concerned in producing the diſeaſe, viz. irritation and ſenſation; and hence, as their combined action is more violent, the general quantity of ſenſorial power becomes further exhauſted during the exacerbation,

tion, and the ſyſtem more rapidly weakened than in irritative fever with ſtrong pulſe; where the ſpirit of animation is weakened by but one mode of its exertion: ſo that this febris ſenſitiva pulſu forti (or inflammatory fever,) may be conſidered as the febris irritativa pulſu forti, with the addition of inflammation; and the febris ſenſitiva pulſu debili (or malignant fever) may be conſidered as the febris irritativa pulſu debili (or nervous fever), with the addition of inflammation.

4. In theſe putrid or malignant fevers a deficiency of irritability accompanies the increaſe of ſenſibility; and by this waſte of ſenſorial power by the exceſs of ſenſation, which was already too ſmall, ariſes the delirium and ſtupor which ſo perpetually attend theſe inflammatory fevers with arterial debility. In theſe caſes the voluntary power firſt ceaſes to act from deficiency of ſenſorial ſpirit; and the ſtimuli from external bodies have no effect on the exhauſted ſenſorial power, and a delirium like a dream is the conſequence. At length the internal ſtimuli ceaſe to excite ſufficient irritation, and the ſecretions are either not produced at all, or too parſimonious in quantity. Amongſt theſe the ſecretion of the brain, or production of the ſenſorial power, becomes deficient, till at laſt all ſenſorial power ceaſes, except what is juſt neceſſary to perform the vital motions, and a ſtupor ſucceeds; which is thus owing to the ſame cauſe as the preceding delirium exerted in a greater degree.

This kind of delirium is owing to a ſuſpenſion of volition, and to the diſobedience of the ſenſes to external ſtimuli, and is always occaſioned by great debility, or paucity of ſenſorial power; it is therefore a bad ſign at the end of inflammatory fevers, which had previous arterial ſtrength, as rheumatiſm, or pleuriſy, as it ſhews the preſence of great exhauſtion of ſenſorial power in a ſyſtem, which having

ing lately been expoſed to great excitement, is not ſo liable to be ſtimulated into its healthy action, either by additional ſtimulus of food and medicines, or by the accumulation of ſenſorial power during its preſent torpor. In inflammatory fevers with debility, as thoſe termed putrid fevers, delirium is ſometimes, as well as ſtupor, rather a favourable ſign; as leſs ſenſorial power is waſted during its continuance (ſee Claſs II. 1. 6. 8.), and the conſtitution not having been previouſly expoſed to exceſs of ſtimulation, is more liable to be excited after previous quieſcence.

When the ſum of general pleaſurable ſenſation becomes too great, another kind of delirium ſupervenes, and the ideas thus excited are miſtaken for the irritations of external objects: ſuch a delirium is produced for a time by intoxicating drugs, as fermented liquors, or opium; a permanent delirium of this kind is ſometimes induced by the pleaſures of inordinate vanity, or by the enthuſiaſtic hopes of heaven. In theſe caſes the power of volition is incapable of exertion, and in a great degree the external ſenſes become incapable of perceiving their adapted ſtimuli, becauſe the whole ſenſorial power is employed or expended on the ideas excited by pleaſurable ſenſation.

This kind of delirium is diſtinguiſhed from that which attends the fevers above mentioned from its not being accompanied with general debility, but ſimply with exceſs of pleaſurable ſenſation; and is therefore in ſome meaſure allied to madneſs or to reverie; it differs from the delirium of dreams, as in this the power of volition is not totally ſuſpended, nor are the ſenſes precluded from external ſtimulation; there is therefore a degree of conſiſtency, in this kind of delirium, and a degree of attention to external objects, neither of which exiſt in the delirium of fevers or in dreams.

5. It

5. It would appear, that the vaſcular ſyſtem of other animals are leſs liable to be put into action by their general ſum of pleaſurable or painful ſenſation; and that the trains of their ideas, and the muſcular motions uſually aſſociated with them, are leſs powerfully connected than in the human ſyſtem. For other animals neither weep, nor ſmile, nor laugh; and are hence ſeldom ſubject to delirium, as treated of in Sect. XVI. on Inſtinct. Now as our epidemic and contagious diſeaſes are probably produced by diſagreeable ſenſation, and not ſimply by irritation; there appears a reaſon, why brute animals are leſs liable to epidemic or contagious diſeaſes; and ſecondly, why none of our contagions, as the ſmall-pox or meaſles, can be communicated to them, though one of theirs, viz. the hydrophobia, as well as many of their poiſons, as thoſe of ſnakes and of inſects, communicate their deleterious or painful effects to mankind.

Where the quantity of general painful ſenſation is too great in the ſyſtem, inordinate voluntary exertions are produced either of our ideas, as in melancholy and madneſs, or of our muſcles, as in convulſion. From theſe maladies alſo brute animals are much more exempt than mankind, owing to their greater inaptitude to voluntary exertion, as mentioned in Sect. XVI. on Inſtinct.

II. 1. When any moving organ is excited into ſuch violent motions, that a quantity of pleaſurable or painful ſenſation is produced, it frequently happens (but not always) that new motions of the affected organ are generated in conſequence of the pain or pleaſure, which are termed inflammation.

Theſe new motions are of a peculiar kind, tending to diſtend the old, and to produce new fibres, and thence to elongate the ſtraight muſcles, which ſerve locomotion, and to form new veſſels at the extremities or ſides of the vaſcular muſcles.

2. Thus

2. Thus the pleaſurable ſenſations produce an enlargement of the nipples of nurſes, of the papillæ of the tongue, of the penis, and probably produce the growth of the body from its embryon ſtate to its maturity; whilſt the new motions in conſequence of painful ſenſation, with the growth of the fibres or veſſels, which they occaſion, are termed inflammation.

Hence when the ſtraight muſcles are inflamed, part of their tendons at each extremity gain new life and ſenſibility, and thus the muſcle is for a time elongated; and inflamed bones become ſoft, vaſcular, and ſenſible. Thus new veſſels ſhoot over the cornea of inflamed eyes, and into ſchirrhous tumours, when they become inflamed; and hence all inflamed parts grow together by intermixture, and inoſculation of the new and old veſſels.

The heat is occaſioned from the increaſed ſecretions either of mucus, or of the fibres, which produce or elongate the veſſels. The red colour is owing to the pellucidity of the newly formed veſſels, and as the arterial parts of them are probably formed before their correſpondent venous parts.

3. Theſe new motions are excited either from the increaſed quantity of ſenſation in conſequence of greater fibrous contractions, or from increaſed ſenſibility, that is, from the increaſed quantity of ſenſorial power in the moving organ. Hence they are induced by great external ſtimuli, as by wounds, broken bones, and by acrid or infectious materials, or by common ſtimuli on thoſe organs, which have been ſome time quieſcent; as the uſual light of the day inflames the eyes of thoſe, who have been confined in dungeons; and the warmth of a common fire inflames thoſe, who have been previouſly expoſed to much cold.

But theſe new motions are never generated by that pain, which ariſes from defect of ſtimulus, as from

from hunger, thirſt, cold, or inanition, with all thoſe pains which are termed nervous. Where theſe pains exiſt, the motions of the affected part are leſſened; and if inflammation ſucceeds, it is in ſome diſtant parts; as coughs are cauſed by coldneſs and moiſture being long applied to the feet; or it is in conſequence of the renewal of the ſtimulus, as of heat or food, which excites our organs into ſtronger action after their temporary quieſcence; as kibed heels after walking in ſnow.

4. But when theſe new motions of the vaſcular muſcles are exerted with greater violence, and theſe veſſels are either elongated too much or too haſtily, a new material is ſecreted from their extremities, which is of various kinds according to the peculiar animal motions of this new kind of gland, which ſecretes it; ſuch is the pus laudabile or common matter, the variolous matter, venereal matter, catarrhous matter, and many others.

5. Theſe matters are the product of an animal proceſs; they are ſecreted or produced from the blood by certain diſeaſed motions of the extremities of the blood-veſſels, and are on that account all of them contagious; for if a portion of any of theſe matters is tranſmitted into the circulation, or perhaps only inſerted into the ſkin, or beneath the cuticle of an healthy perſon, its ſtimulus in a certain time produces the ſame kind of morbid motions, by which itſelf was produced; and hence a ſimilar kind is generated. See Sect. XXXIX. 6. 1.

6. It is remarkable, that many of theſe contagious matters are capable of producing a ſimilar diſeaſe but once; as the ſmall-pox and meaſles; and I ſuppoſe this is true of all thoſe contagious diſeaſes, which are ſpontaneouſly cured by nature in a certain time; for if the body was capable of receiving the diſeaſe a ſecond time, the patient muſt perpetually infect himſelf by the very matter, which he

he has himſelf produced, and is lodged about him; and hence he could never become free from the diſeaſe. Something ſimilar to this is ſeen in the ſecondary fever of the confluent ſmall-pox; there is a great abſorption of variolous matter, a very minute part of which would give the genuine ſmall-pox to another perſon; but here it only ſtimulates the ſyſtem into common fever; like that which common pus, or any other acrid material might occaſion.

7. In the pulmonary conſumption, where common matter is daily abſorbed, an irritative fever only, without new inflammation, is generally produced; which is terminated like other irritative fevers by ſweats or looſe ſtools. Hence it does not appear, that this abſorbed matter always acts as a contagious material producing freſh inflammation or new abſceſſes. Though there is reaſon to believe, that the firſt time any common matter is abſorbed, it has this effect, but not the ſecond time, like the variolous matter above mentioned.

This accounts for the opinion, that the pulmonary conſumption is ſometimes infectious, which opinion was held by the ancients, and continues in Italy at preſent; and I have myſelf ſeen three or four inſtances, where a huſband and wife, who have ſlept together, and have thus much received each other's breath, who have infected each other, and both died in conſequence of the original taint of only one of them. This alſo accounts for the abſceſſes in various parts of the body, that are ſometimes produced after the inoculated ſmall-pox is terminated; for this ſecond abſorption of variolous matter acts like common matter, and produces only irritative fever in thoſe children, whoſe conſtitutions have already experienced the abſorption of common matter; and inflammation with a tendency to produce new abſceſſes in thoſe, whoſe conſtitutions have

have not experienced the abſorptions of common matter.

It is probable, that more certain proofs might have been found to ſhew, that common matter is infectious the firſt time it is abſorbed, tending to produce ſimilar abſceſſes, but not the ſecond time of its abſorption, if this ſubject had been attended to.

8. Theſe contagious diſeaſes are very numerous, as the plague, ſmall-pox, chicken-pox, meaſles, ſcarlet-fever, pemphigus, catarrh, chincough, venereal diſeaſe, itch, trichoma, tinea. The infectious material does not ſeem to be diſſolved by the air, but only mixed with it perhaps in fine powder, which ſoon ſubſides; ſince many of theſe contagions can only be received by actual contact, and others of them only at ſmall diſtances from the infected perſon, as is evident from many perſons having been near patients of the ſmall-pox without acquiring the diſeaſe.

The reaſon why many of theſe diſeaſes are received but once, and others repeatedly, is not well underſtood; it appears to me, that the conſtitution becomes ſo accuſtomed to the ſtimuli of theſe infectious materials, by having once experienced them, that though irritative motions, as hectic fevers, may again be produced by them, yet no ſenſation, and in conſequence no general inflammation ſucceeds; as diſagreeable ſmells or taſtes by habits ceaſe to be perceived; they continue indeed to excite irritative ideas on the organs of ſenſe, but theſe are not ſucceeded by ſenſation.

There are many irritative motions, which were at firſt ſucceeded by ſenſation, but which by frequent repetition ceaſe to excite ſenſation, as explained in Sect. XX. on Vertigo. And, that this circumſtance exiſts in reſpect to infectious matter appears from a known fact; that nurſes, who have had the ſmall-pox, are liable to experience ſmall ulcers on their

their arms by the contact of variolous matter in lifting their patients; and that when patients, who have formerly had the ſmall-pox have been inoculated in the arm, a phlegmon, or inflamed ſore, has ſucceeded, but no ſubſequent fever. Which ſhews, that the contagious matter of the ſmall-pox has not loſt its power of ſtimulating the part it is applied to, but that the general ſyſtem is not affected in conſequence. See Sect. XII. 7. 6. XIX. 10.

9. From the accounts of the plague, virulent catarrh, and putrid dyſentery, it ſeems uncertain, whether theſe diſeaſes are experienced more than once; but the venereal diſeaſe and itch are doubtleſs repeatedly infectious; and as theſe diſeaſes are never cured ſpontaneouſly, but require medicines, which act without apparent operation, ſome have ſuſpected, that the contagious material produces ſimilar matter rather by a chemical change of the fluids, than by an animal proceſs; and that the ſpecific medicines deſtroy their virus by chemically combining with it. This opinion is ſucceſsfully combated by Mr. Hunter, in his Treatiſe on Venereal Diſeaſe, Part I. c. i.

But this opinion wants the ſupport of analogy, as there is no known proceſs in animal bodies, which is purely chemical, not even digeſtion; nor can any of theſe matters be produced by chemical proceſſes. Add to this, that it is probable, that the inſects, obſerved in the puſtules of the itch, and in the ſtools of dyſenteric patients, are the conſequences, and not the cauſes of theſe diſeaſes. And that the ſpecific medicines, which cure the itch and lues venerea, as brimſtone and mercury, act only by increaſing the abſorption of the matter in the ulcuſcles of thoſe diſeaſes, and thence diſpoſing them to heal; which would otherwiſe continue to ſpread.

Why the venereal diſeaſe, and itch, and tenia, or ſcald head, are repeatedly contagious, while thoſe contagions

contagions attended with fever can be received but once, ſeems to depend on their being rather local diſeaſes than univerſal ones, and are hence not attended with fever, except the purulent fever in their laſt ſtages, when the patient is deſtroyed by them. On this account the whole of the ſyſtem does not become habituated to theſe morbid actions, ſo as to ceaſe to be affected with ſenſation by a repetition of the contagion. Thus the contagious matter of the venereal diſeaſe, and of the tenia, affects the lymphatic glands, as the inguinal glands, and thoſe about the roots of the hair and neck, where it is arreſted, but does not ſeem to affect the blood-veſſels, ſince no fever enſues.

Hence it would appear, that theſe kinds of contagion are propagated not by means of the circulation, but by ſympathy of diſtant parts with each other; ſince if a diſtant part, as the palate, ſhould be excited by ſenſitive aſſociation into the ſame kind of motions, as the parts originally affected by the contact of infectious matter; that diſtant part will produce the ſame kind of infectious matter; for every ſecretion from the blood is formed from it by the peculiar motions of the fine extremities of the gland, which ſecretes it; the various ſecreted fluids, as the bile, ſaliva, gaſtric juice, not previouſly exiſting, as ſuch, in the blood-veſſels.

And this peculiar ſympathy between the genitals and the throat, owing to ſenſitive aſſociation, appears not only in the production of venereal ulcers in the throat, but in variety of other inſtances, as in the mumps, in the hydrophobia, ſome coughs, ſtrangulation, the production of the beard, change of voice at puberty. Which are further deſcribed in Claſs IV. 1. 2. 7.

To evince that the production of ſuch large quantities of contagious matter, as are ſeen in ſome

variolous patients, ſo as to cover the whole ſkin almoſt with puſtules, does not ariſe from any chemical fermentation in the blood, but that it is owing to morbid motions of the fine extremities of the capillaries, or glands, whether theſe be ruptured or not, appears from the quantity of this matter always correſponding with the quantity of the fever; that is, with the violent exertions of thoſe glands and capillaries, which are the terminations of the arterial ſyſtem.

The truth of this theory is evinced further by a circumſtance obſerved by Mr. J. Hunter, in his Treatiſe on Venereal Diſeaſe; that in a patient, who was inoculated for the ſmall-pox, and who appeared afterwards to have been previouſly infected with the meaſles, the progreſs of the ſmall-pox was delayed till the meaſles had run their courſe, and that then the ſmall-pox went through its uſual periods.

Two ſimilar caſes fell under my care, which I ſhall here relate, as it confirms that of Mr. Hunter, and contributes to illuſtrate this part of the theory of contagious diſeaſes. I have tranſcribed the particulars from a letter of Mr. Lightwood of Yoxal, the ſurgeon who daily attended them, and at my requeſt, after I had ſeen them, kept a kind of journal of their caſes.

Miſs H. and Miſs L. two ſiſters, the one about four and the other about three years old, were inoculated Feb. 7, 1791. On the 10th there was a redneſs on both arms diſcernible by a glaſs. On the 11th their arms were ſo much inflamed as to leave no doubt of the infection having taken place. On the 12th leſs appearance of inflammation on their arms. In the evening Miſs L. had an eruption, which reſembled the meaſles. On the 13th the eruption on Miſs L. was very full on the face and breaſt, like the meaſles, with conſiderable fever. It was now known, that the meaſles were in a farm houſe

houſe in the neighbourhood. Miſs H.'s arm leſs inflamed than yeſterday. On the 14th Miſs L.'s fever great, and the eruption univerſal. The arm appears to be healed. Miſs H.'s arm ſomewhat redder. They were now put into ſeparate rooms. On the 15th Miſs L.'s arms as yeſterday. Eruption continues. Miſs H.'s arms have varied but little. 16th, the eruptions on Miſs L. are dying away, her fever gone. Begins to have a little redneſs in one arm at the place of inoculation. Miſs H.'s arms get redder, but ſhe has no appearance of complaint. 20th, Miſs L.'s arms have advanced ſlowly till this day, and now a few puſtules appear. Miſs H.'s arm has made little progreſs from the 16th to this day, and now ſhe has ſome fever. 21ſt, Miſs L. as yeſterday. Miſs H. has much inflammation, and an increaſe of the red circle on one arm to the ſize of half a crown, and had much fever at night, with fetid breath. 22d, Miſs L.'s puſtules continue advancing. Miſs H.'s inflammation of her arm and red circle increaſes. A few red ſpots appear in different parts with ſome degree of fever this morning. 23d, Miſs L. has a larger crop of puſtules. Miſs H. has ſmall puſtules and great inflammation of her arms, with but one puſtule likely to ſuppurate. After this day they gradually got well, and the puſtules diſappeared.

In one of theſe caſes the meaſles went through their common courſe with milder ſymptoms than uſual, and in the other the meaſly contagion ſeemed juſt ſufficient to ſtop the progreſs of variolous contagion, but without itſelf throwing the conſtitution into any diſorder. At the ſame time both the meaſles and ſmall-pox ſeem to have been rendered milder. Does not this give an idea, that if they were both inoculated at the ſame time, neither of them might affect the patient?

From theſe caſes I contend, that the contagious matter of theſe diſeaſes does not affect the conſtitution by a fermentation, or chemical change of the blood, becauſe then they muſt have proceeded together, and have produced a third ſomething, not exactly ſimilar to either of them: but that they produce new motions of the cutaneous terminations of the blood-veſſels, which for a time proceed daily with increaſing activity, like ſome paroxyſms of fever, till they at length ſecrete or form a ſimilar poiſon by theſe unnatural actions.

Now as in the meaſles one kind of unnatural motion takes place, and in the ſmall-pox another kind, it is eaſy to conceive, that theſe different kinds of morbid motions cannot exiſt together; and therefore, that that which has firſt begun will continue till the ſyſtem becomes habituated to the ſtimulus which occaſions it, and has ceaſed to be thrown into action by it; and then the other kind of ſtimulus will in its turn produce fever, and new kinds of motions peculiar to itſelf.

10. On further conſidering the action of contagious matter, ſince the former part of this work was ſent to the preſs; where I have aſſerted, in Sect. XXII. 4. 3. that it is probable, that the variolous matter is diffuſed through the blood; I prevailed on my friend Mr. Power, ſurgeon at Boſworth in Leiceſterſhire to try, whether the ſmall-pox could be inoculated by uſing the blood of a variolous patient inſtead of the matter from the puſtules; as I thought ſuch an experiment might throw ſome light at leaſt on this intereſting ſubject. The following is an extract from his letter:—

"March 11, 1793. I inoculated two children, who had not had the ſmall-pox, with blood; which was taken from a patient on the ſecond day after the eruption commenced, and before it was completed. And at the ſame time I inoculated myſelf with blood

blood from the ſame perſon, in order to compare the appearances, which might ariſe in a perſon liable to receive the infection, and in one not liable to receive it. On the ſame day I inoculated four other children liable to receive the infection with blood taken from another perſon on the fourth day after the commencement of the eruption. The patients from whom the blood was taken had the diſeaſe mildly, but had the moſt puſtules of any I could ſelect from twenty inoculated patients; and as much of the blood was inſinuated under the cuticle as I could introduce by elevating the ſkin without drawing blood; and three or four ſuch punctures were made in each of their arms, and the blood was uſed in its fluid ſtate.

"As the appearances in all theſe patients, as well as in myſelf, were ſimilar, I ſhall only mention them in general terms. March 13. A ſlight ſubcuticular diſcoloration, with rather a livid appearance, without ſoreneſs or pain, was viſible in them all, as well as in my own hand. 15. The diſcoloration ſomewhat leſs, without pain or ſoreneſs. Some patients inoculated on the ſame day with variolous matter have conſiderable inflammation. 17. The diſcoloration is quite gone in them all, and from my own hand, a dry mark only remaining. And they were all inoculated on the 18th, with variolous matter, which produced the diſeaſe in them all."

Mr. Power afterwards obſerves, that, as the patients from whom the blood was taken had the diſeaſe mildly, it may be ſuppoſed, that though the contagious matter might be mixed with the blood, it might ſtill be in too dilute a ſtate to convey the infection; but adds at the ſame time, that he has diluted recent matter with at leaſt five times its quantity of water, and which has ſtill given the infection; though he has ſometimes diluted it ſo far as to fail.

The

The following experiments were inſtituted at my requeſt by my friend Mr. Hadley, ſurgeon in Derby, to aſcertain whether the blood of a perſon in the ſmall-pox be capable of communicating the diſeaſe.

"Experiment 1ſt. October 18th, 1793. I took ſome blood from a vein in the arm of a perſon who had the ſmall-pox, on the ſecond day of the eruption, and introduced a ſmall quantity of it immediately with the point of a lancet between the ſcarf and true ſkin of the right arm of a boy nine years old in two or three different places; the other arm was inoculated with variolous matter at the ſame time.

"19th. The punctured parts of the right arm were ſurrounded with ſome degree of ſubcuticular inflammation. 20th. The inflammation more conſiderable, with a ſlight degree of itching, but no pain upon preſſure. 21ſt. Upon examining the arm this day with a lens I found the inflammation leſs extenſive, and the redneſs changing to a deep yellow or orange-colour. 22d. Inflammation nearly gone. 23d. Nothing remained, except a ſlight diſcoloration and a little ſcurfy appearance on the punctures. At the ſame the inflammation of the arm inoculated with variolous matter was increaſing faſt, and he had the diſeaſe mildly at the uſual time.

"Experiment 2d. I inoculated another child at the ſame time and in the ſame manner, with blood taken on the firſt day of the eruption; but as the appearance and effects were ſimilar to thoſe in the preceding experiment, I ſhall not relate them minutely.

"Experiment 3d. October 20th. Blood was taken from a perſon who had the ſmall-pox, on the third day of the eruption, and on the ſixth from the commencement of the eruptive fever. I introduced ſome of it in its fluid ſtate into both arms of a boy ſeven years old. 21ſt. There appeared to be ſome inflammation

inflammation under the cuticle, where the punctures were made. 22d. Inflammation more conſiderable. 23d. On this day the inflammation was ſomewhat greater, and the cuticle rather elevated.

" 24th. Inflammation much leſs, and only a brown or orange colour remained. 25th. Scarcely any diſcoloration left. On this day he was inoculated with variolous matter, the progreſs of the infection went on in the uſual way, and he had the ſmall-pox very favourably.

" At this time I was requeſted to inoculate a young perſon, who was thought to have had the ſmall-pox, but his parents were not quite certain; in one arm I introduced variolous matter, and in the other blood, taken as in experiment 3d. On the ſecond day after the operation, the punctured parts were inflamed, though I think the arm in which I had inſerted variolous matter was rather more ſo than the other. On the third the inflammation was increaſed, and looked much the ſame as in the preceding experiment. 4th. The inflammation was much diminiſhed, and on the 5th almoſt gone. He was expoſed at the ſame time to the natural infection, but has continued perfectly well.

" I have frequently obſerved (and believe moſt practitioners have done the ſame), that if variolous matter be inſerted in the arm of a perſon who has previouſly had the ſmall-pox, the inflammation on the ſecond or third days is much greater, than if they had not had the diſeaſe, but on the fourth or fifth it diſappears.

" On the 23d I introduced blood into the arms of three more children, taken on the third and fourth days of the eruption. The appearances were much the ſame as mentioned in experiments firſt and third. They were afterwards inoculated with variolous matter, and had the diſeaſe in the regular way.

" The

"The above experiments were made with blood taken from a ſmall vein in the hand or foot of three or four different patients, whom I had at that time under inoculation. They were ſelected from 160, as having the greateſt number of puſtules. The part was waſhed with warm water before the blood was taken, to prevent the poſſibility of any matter being mixed with it from the ſurface."

Shall we conclude from hence, that the variolous matter never enters the blood-veſſels? but that the morbid motions of the veſſels of the ſkin around the inſertion of it continue to increaſe in a larger and larger circle for ſix or ſeven days; that then their quantity of morbid action becomes great enough to produce a fever-fit, and to affect the ſtomach by aſſociation of motions? and finally, that a ſecond aſſociation of motions is produced between the ſtomach and the other parts of the ſkin, inducing them into morbid actions ſimilar to thoſe of the circle round the inſertion of the variolous matter? Many more experiments and obſervations are required before this important queſtion can be ſatisfactorily anſwered.

It may be adduced, that the matter inſerted into the ſkin of the arm frequently ſwells the lymphatic in the axilla, that in that circumſtance it ſeems to be there arreſted in its progreſs, and cannot be imagined to enter the blood by that lymphatic gland till the ſwelling of it ſubſides. Some other phænomena of the diſeaſe are more eaſily reconcileable to this theory of ſympathetic motions than to that of abſorption; as the time taken up between the inſertion of the matter, and the operation of it on the ſyſtem, as mentioned above. For the circle around the inſertion is ſeen to increaſe, and to inflame; and I believe, undergoes a kind of diurnal paroxyſm of torpor and paleneſs with a ſucceeding increaſe of action and colour, like a topical fever-fit. Whereas

if

if the matter is conceived to circulate for ſix or ſeven days with the blood, without producing diſorder, it ought to be rendered milder, or the blood-veſſels more familiarized to its acrimony.

It is much eaſier to conceive from this doctrine of aſſociated or ſympathetic motions of diſtant parts of the ſyſtem, how it happens, that the variolous infection can be received but once, as before explained; than by ſuppoſing, that a change is effected in the maſs of blood by any kind of fermentative proceſs.

The curious circumſtance of the two contagions of ſmall-pox and meaſles not acting at the ſame time, but one of them reſting or ſuſpending its action till that of the other ceaſes, may be much eaſier explained from ſympathetic or aſſociated actions of the infected part with other parts of the ſyſtem, than it can from ſuppoſing the two contagions to enter the circulation.

The ſkin of the face is ſubject to more frequent viciſſitudes of heat and cold, from its expoſure to the open air, and is in conſequence more liable to ſenſitive aſſociation with the ſtomach than any other part of the ſurface of the body, becauſe their actions have been more frequently thus aſſociated. Thus in a ſurfeit from drinking cold water, when a perſon is very hot and fatigued, an eruption is liable to appear on the face in conſequence of this ſympathy. In the ſame manner the roſy eruption on the faces of drunkards more probably ariſes from the ſympathy of the face with the ſtomach, rather than between the face and the liver, as is generally ſuppoſed.

This ſympathy between the ſtomach and the ſkin of the face is apparent in the eruption of the ſmall-pox; ſince, where the diſeaſe is in conſiderable quantity, the eruption of the face firſt ſucceeds the ſickneſs of the ſtomach. In the natural diſeaſe the

ſtomach

ſtomach ſeems to be frequently primarily affected, either alone or along with the tonſils, as the matter ſeems to be only diffuſed in the air, and by being mixed with the ſaliva, or mucus of the tonſils, to be ſwallowed into the ſtomach.

After ſome days the irritative circles of motions become diſordered by this new ſtimulus, which acts upon the mucous lining of the ſtomach; and ſickneſs, vertigo, and a diurnal fever ſucceed. Theſe diſordered irritative motions become daily increaſed for two or three days, and then by their increaſed action certain ſenſitive motions, or inflammation, is produced, and at the next cold fit of fever, when the ſtomach recovers from its torpor, an inflammation of the external ſkin is formed in points (which afterwards ſuppurate), by ſenſitive aſſociation, in the ſame manner as a cough is produced in conſequence of expoſing the feet to cold, as deſcribed in Sect. XXV. 1. 1. and Claſs IV. 2. 1. 7. If the inoculated ſkin of the arm, as far as it appears inflamed, was to be cut out, or deſtroyed by cauſtic, before the fever commenced, as ſuppoſe on the fourth day after inoculation, would this prevent the diſeaſe? as it is ſuppoſed to prevent the hydrophobia.

III. 1. Where the new veſſels, and enlarged old ones, which conſtitute inflammation are not ſo haſtily diſtended as to burſt, and form a new kind of gland for the ſecretion of matter, as above mentioned; if ſuch circumſtances happen as diminiſh the painful ſenſation, the tendency to growth ceaſes, and by and by an abſorption commences, not only of the ſuperabundant quantity of fluids depoſited in the inflamed part, but of the ſolids likewiſe, and this even of the hardeſt kind.

Thus during the growth of the ſecond ſet of teeth in children, the roots of the firſt ſet are totally abſorbed, till at length nothing of them remains but the crown; though a few weeks before, if,

if they are drawn immaturely, their roots are found complete. Similar to this Mr. Hunter has obſerved, that where a dead piece of bone is to exfoliate, or to ſeparate from a living one, the dead part does not putrefy, but remains perfectly ſound, while the ſurface of the living part of the bone, which is in contact with the dead part, becomes abſorbed, and thus effects its ſeparation. Med. Comment. Edinb. V. 1. 425. In the ſame manner the calcareous matter of gouty concretions, the coagulable lymph depoſited on inflamed membranes in rheumatiſm and extravaſated blood become abſorbed; which are all as ſolid and as indiſſoluble materials as the new veſſels produced in inflammation.

This abſorption of the new veſſels and depoſited fluids of inflamed parts is called reſolution: it is produced by firſt uſing ſuch internal means as decreaſe the pain of the part, and in conſequence its new motions, as repeated bleeding, cathartics, diluent potations, and warm bath.

After the veſſels are thus emptied, and the abſorption of the new veſſels and depoſited fluids is evidently begun, it is much promoted by ſtimulating the part externally by ſolutions of lead, or other metals, and internally by the bark, and ſmall doſes of opium. Hence when an ophthalmy begins to become paler, any acrid eye-water, as a ſolution of ſix grains of white vitriol in an ounce of water, haſtens the abſorption, and clears the eye in a very ſhort time. But the ſame application uſed a few days ſooner would have increaſed the inflammation. Hence after evacuation opium in ſmall doſes may contribute to promote the abſorption of fluids depoſited on the brain, as obſerved by Mr. Bromfield in his treatiſe of ſurgery.

2. Where an abſceſs is formed by the rupture of theſe new veſſels, the violence of inflammation ceaſes, and a new gland ſeparates a material called pus;

pus: at the ſame time a leſs degree of inflammation produces new veſſels called vulgarly proud fleſh; which, if no bandage confines its growth, nor any other circumſtance promotes abſorption in the wound, would riſe to a great height above the uſual ſize of the part.

Hence the art of healing ulcers conſiſts in producing a tendency to abſorption in the wound greater than the depoſition. Thus when an ill-conditioned ulcer ſeparates a copious and thin diſcharge, by the uſe of any ſtimulus, as of ſalts of lead, or mercury, or copper externally applied, the diſcharge becomes diminiſhed in quantity, and becomes thicker, as the thinner parts are firſt abſorbed.

But nothing ſo much contributes to increaſe the abſorption in a wound as covering the whole limb above the ſore with a bandage, which ſhould be ſpread with ſome plaſter, as with emplaſtrum de minio, to prevent it from ſlipping. By this artificial tightneſs of the ſkin, the arterial pulſations act with double their uſual power in promoting the aſcending current of the fluid in the valvular lymphatics.

Internally the abſorption from ulcers ſhould be promoted firſt by evacuation, then by opium, bark, mercury, ſteel.

3. Where the inflammation proceeds with greater violence or rapidity, that is, when by the painful ſenſation a more inordinate activity of the organ is produced, and by this great activity an additional quantity of painful ſenſation follows in an increaſing ratio, till the whole of the ſenſorial power, or ſpirit of animation, in the part becomes exhauſted, a mortification enſues, as in a carbuncle, in inflammations of the bowels, in the extremities of old people, or in the limbs of thoſe who are brought near a fire after having been much benumbed with cold.

And

And from hence it appears, why weak people are more ſubject to mortification than ſtrong ones, and why in weak perſons leſs pain will produce mortification, namely, becauſe the ſenſorial power is ſooner exhauſted by any exceſs of activity. I remember ſeeing a gentleman who had the preceding day travelled two ſtages in a chaiſe with what he termed a bearable pain in his bowels; which when I ſaw him had ceaſed rather ſuddenly, and without a paſſage through him; his pulſe was then weak, though not very quick; but as nothing which he ſwallowed would continue in his ſtomach many minutes, I concluded that the bowel was mortified; he died on the next day. It is uſual for patients ſinking under the ſmall-pox with mortified puſtules, and with purple ſpots intermixed, to complain of no pain, but to ſay they are pretty well to the laſt moment.

Recapitulation.

IV. When the motions of any part of the ſyſtem, in conſequence of previous torpor, are performed with more energy than in the irritative fevers, a diſagreeable ſenſation is produced, and new actions of ſome part of the ſyſtem commence in conſequence of this ſenſation conjointly with the irritation: which motions conſtitute inflammation. If the fever be attended with a ſtrong pulſe, as in pleuriſy, or rheumatiſm, it is termed ſynocha ſenſitiva, or ſenſitive fever with ſtrong pulſe; which is uſually termed inflammatory fever. If it be attended with weak pulſe, it is termed typhus ſenſitivus, or ſenſitive fever with weak pulſe, or typhus gravior, or putrid malignant fever.

The ſynocha ſenſitiva, or ſenſitive fever with ſtrong pulſe, is generally attended with ſome topical inflammation, as in peripneumony, hepatitis, and is accompanied

accompanied with much coagulable lymph, or ſize; which riſes to the ſurface of the blood, when taken into a baſon, as it cools; and which is believed to be the increaſed mucous ſecretion from the coats of the arteries, inſpiſſated by a greater abſorption of its aqueous and ſaline parts, and perhaps changed by its delay in the circulation.

The typhus ſenſitivus, or ſenſitive fever with weak pulſe, is frequently attended with delirium, which is cauſed by the deficiency of the quantity of ſenſorial power, and with variety of cutaneous eruptions.

Inflammation is cauſed by the pains occaſioned by exceſs of action, and not by thoſe pains which are occaſioned by defect of action. Theſe morbid actions, which are thus produced by two ſenſorial powers, viz. by irritation and ſenſation, ſecrete new living fibres, which elongate the old veſſels, or form new ones, and at the ſame time much heat is evolved from theſe combinations. By the rupture of theſe veſſels, or by a new conſtruction of their apertures, purulent matters are ſecreted of various kinds; which are infectious the firſt time they are applied to the ſkin beneath the cuticle, or ſwallowed with the ſaliva into the ſtomach. This contagion acts not by its being abſorbed into the circulation, but by the ſympathies, or aſſociated actions, between the part firſt ſtimulated by the contagious matter and the other parts of the ſyſtem. Thus in the natural ſmall-pox the contagion is ſwallowed with the ſaliva, and by its ſtimulus inflames the ſtomach; this variolous inflammation of the ſtomach increaſes every day, like the circle round the puncture of an inoculated arm, till it becomes great enough to diſorder the circles of irritative and ſenſitive motions, and thus produces fever-fits, with ſickneſs and vomiting. Laſtly, after the cold paroxyſm, or fit of torpor, of the ſtomach has increaſed for two or three ſucceſſive

ſive days, an inflammation of the ſkin commences in points; which generally firſt appear upon the face, as the aſſociated actions between the ſkin of the face and that of the ſtomach have been more frequently exerted together than thoſe of any other parts of the external ſurface.

Contagious matters, as thoſe of the meaſles and ſmall-pox, do not act upon the ſyſtem at the ſame time; but the progreſs of that which was laſt received is delayed, till the action of the former infection ceaſes. All kinds of matter, even that from common ulcers, are probably contagious the firſt time they are inſerted beneath the cuticle or ſwallowed into the ſtomach; that is, as they were formed by certain morbid actions of the extremities of the veſſels, they have the power to excite ſimilar morbid actions in the extremities of other veſſels, to which they are applied; and theſe by ſympathy, or aſſociations of motion, excite ſimilar morbid actions in diſtant parts of the ſyſtem, without entering the circulation; and hence the blood of a patient in the ſmall-pox will not give that diſeaſe by inoculation to others.

When the new fibres or veſſels become again abſorbed into the circulation, the inflammation ceaſes; which is promoted, after ſufficient evacuations, by external ſtimulants and bandages: but where the action of the veſſels is very great, a mortification of the part is liable to enſue, owing to the exhauſtion of ſenſorial power; which however occurs in weak people without much pain, and without very violent previous inflammation; and, like partial paralyſis, may be eſteemed one mode of natural death of old people, a part dying before the whole.

SECT.

SECT. XXXIV.

DISEASES OF VOLITION.

I. 1. *Volition defined. Motions termed involuntary are caused by volition. Desires opposed to each other. Deliberation. Ass between two hay-cocks. Saliva swallowed against one's desire. Voluntary motions distinguished from those associated with sensitive motions.* 2. *Pains from excess, and from defect of motion. No pain is felt during vehement voluntary exertion; as in cold fits of ague, labour-pains, strangury, tenesmus, vomiting, restlessness in fevers, convulsion of a wounded muscle.* 3. *Of holding the breath and screaming in pain; why swine and dogs cry out in pain, and not sheep and horses. Of grinning and biting in pain; why mad animals bite others.* 4. *Epileptic convulsions explained, why the fits begin with quivering of the under jaw, biting the tongue, and setting the teeth; why the convulsive motions are alternately relaxed. The phænomenon of laughter explained. Why children cannot tickle themselves. How some have died from immoderate laughter.* 5. *Of cataleptic spasms, of the locked jaw, of painful cramps.* 6. *Syncope explained. Why no external objects are perceived in syncope.* 7. *Of palsy and apoplexy from violent exertions. Case of Mrs. Scot. From dancing, scating, swimming. Case of Mr. Nairn. Why palsies are not always immediately preceded by violent exertions. Palsy and epilepsy from diseased livers. Why the right arm more frequently paralytic than the left. How paralytic limbs regain their motions.* II. *Diseases of the sensual motions from*

from exceſs or defect of voluntary exertion. 1. *Madneſs.* 2. *Diſtinguiſhed from delirium.* 3. *Why mankind more liable to inſanity than brutes.* 4. *Suſpicion. Want of ſhame, and of cleanlineſs.* 5. *They bear cold, hunger, and fatigue. Charles* XII. *of Sweden.* 6. *Pleaſurable delirium, and inſanity. Child riding on a ſtick. Pains of martyrdom not felt.* 7. *Dropſy.* 8. *Inflammation cured by inſanity.* III. 1. *Pain relieved by reverie. Reverie is an exertion of voluntary and ſenſitive motions.* 2. *Caſe of reverie.* 3. *Lady ſuppoſed to have two ſouls.* 4. *Methods of relieving pain.*

I. 1. BEFORE we commence this Section on Diſeaſed Voluntary Motions, it may be neceſſary to premiſe, that the word volition is not uſed in this work exactly in its common acceptation. Volition is ſaid in Section V. to bear the ſame analogy to deſire and averſion, which ſenſation does to pleaſure and pain. And hence that, when deſire or averſion produces any action of the muſcular fibres, or of the organs of ſenſe, they are termed volition; and the actions produced in conſequence are termed voluntary actions. Whence it appears, that motions of our muſcles or ideas may be produced in conſequence of deſire or averſion without our having the power to prevent them, and yet theſe motions may be termed voluntary, according to our definition of the word; though in common language they would be called involuntary.

The objects of deſire and averſion are generally at a diſtance, whereas thoſe of pleaſure and pain are immediately acting upon our organs. Hence, before deſire or averſion are exerted, ſo as to cauſe any actions, there is generally time for deliberation; which conſiſts in diſcovering the means to obtain the object of deſire, or to avoid the object of averſion; or in examining the good or bad conſequences

which may reſult from them. In this caſe it is evident, that we have a power to delay the propoſed action, or to perform it; and this power of chooſing, whether we ſhall act or not, is in common language expreſſed by the word volition, or will. Whereas in this work the word volition means ſimply the active ſtate of the ſenſorial faculty in producing motion in conſequence of deſire or averſion: whether we have the power of reſtraining that action, or not; that is, whether we exert any actions in conſequence of oppoſite deſires or averſions, or not.

For if the objects of deſire or averſion are preſent, there is no neceſſity to inveſtigate or compare the *means* of obtaining them, nor do we always deliberate about their conſequences; that is, no deliberation neceſſarily intervenes, and in conſequence the power of chooſing to act or not is not exerted. It is probable, that this twofold uſe of the word volition in all languages has confounded the metaphyſicians, who have diſputed about free will and neceſſity. Whereas from the above analyſis it would appear, that during our ſleep, we uſe no voluntary exertions at all; and in our waking hours, that they are the conſequence of deſire or averſion.

To will is to act in conſequence of deſire; but to deſire means to deſire ſomething, even if that ſomething be only to become free from the pain, which cauſes the deſire; for to deſire nothing is not to deſire; the word deſire, therefore, includes both the action and the object or motive; for the object and motive of deſire are the ſame thing. Hence to deſire without an object, that is, without a motive, is a ſoleciſm in language. As if one ſhould aſk, if you could eat without food, or breathe without air.

From this account of volition it appears, that convulſions of the muſcles, as in epileptic fits, may in the common ſenſe of that word be termed involuntary;

tary; becauſe no deliberation is interpoſed between the deſire or averſion and the conſequent action; but in the ſenſe of the word, as above defined, they belong to the claſs of voluntary motions, as delivered in Vol. II. Claſs III. If this uſe of the word be diſcordant to the ear of the reader, the term morbid voluntary motions, or motions in conſequence of averſion, may be ſubſtituted in its ſtead.

If a perſon has a deſire to be cured of the ague, and has at the ſame time an averſion (or contrary deſire) to ſwallowing an ounce of Peruvian bark; he balances deſire againſt deſire, or averſion againſt averſion; and thus he acquires the power of chooſing, which is the common acceptation of the word *willing*. But in the cold fit of ague, after having diſcovered that the act of ſhuddering, or exerting the ſubcutaneous muſcles, relieves the pain of cold; he immediately exerts this act of volition, and ſhudders, as ſoon as the pain and conſequent averſion return, without any deliberation intervening; yet is this act, as well as that of ſwallowing an ounce of the bark, cauſed by volition; and that even though he endeavours in vain to prevent it by a weaker contrary volition. This recalls to our mind the ſtory of the hungry aſs between two hay-ſtacks, where the two deſires are ſuppoſed ſo exactly to counteract each other, that he goes to neither of the ſtacks, but periſhes by want. Now as two equal and oppoſite deſires are thus ſuppoſed to balance each other, and prevent all action, it follows, that if one of theſe hay-ſtacks was ſuddenly removed, the aſs would irreſiſtibly be hurried to the other, which in the common uſe of the word might be called an involuntary act; but which, in our acceptation of it, would be claſſed amongſt voluntary actions, as above explained.

Hence to deliberate is to compare oppoſing deſires or averſions, and that which is the moſt intereſting

at length prevails, and produces action. Similar to this, where two pains oppoſe each other, the ſtronger or more intereſting one produces action; as in pleuriſy the pain from ſuffocation would produce expanſion of the lungs, but the pain occaſioned by extending the inflamed membrane, which lines the cheſt, oppoſes this expanſion, and one or the other alternately prevails.

When any one moves his hand quickly near another perſon's eyes, the eye-lids inſtantly cloſe; this act in common language is termed involuntary, as we have not time to deliberate or to exert any contrary deſire or averſion, but in this work it would be termed a voluntary act, becauſe it is cauſed by the faculty of volition, and after a few trials the nictitation can be prevented by a contrary or oppoſing volition.

The power of oppoſing volitions is beſt exemplified in the ſtory of Mutius Scævola, who is ſaid to have thruſt his hand into the fire before Porſenna, and to have ſuffered it to be conſumed for having failed him in his attempt on the life of that prince. Here the averſion for the loſs of fame, or the unſatisfied deſire to ſerve his country, the two prevalent enthuſiaſms at that time, were more powerful than the deſire of withdrawing his hand, which muſt be occaſioned by the pain of combuſtion; of theſe oppoſing volitions

Vicit amor patriæ, laudumque immenſa cupi do.

If any one is told not to ſwallow his ſaliva for a minute, he ſoon ſwallows it contrary to his will, in the common ſenſe of that word; but this alſo is a voluntary action, as it is performed by the faculty of volition, and is thus to be underſtood. When the power of volition is exerted on any of our ſenſes, they become more acute, as in our attempts to hear

ſmall

ſmall noiſes in the night. As explained in Section XIX. 6. Hence by our attention to the fauces from our deſire not to ſwallow our ſaliva; the fauces become more ſenſible; and the ſtimulus of the ſaliva is followed by greater ſenſation, and conſequent deſire of ſwallowing it. So that the deſire or volition in conſequence of the increaſed ſenſation of the ſaliva is more powerful, than the previous deſire not to ſwallow it. See Vol. II. Deglutitio invita. In the ſame manner if a modeſt man wiſhes not to want to make water, when he is confined with ladies in a coach or an aſſembly-room; that very act of volition induces the circumſtance, which he wiſhes to avoid, as above explained; inſomuch that I once ſaw a partial inſanity, which might be called a voluntary diabetes, which was occaſioned by the fear (and conſequent averſion) of not being able to make water at all.

It is further neceſſary to obſerve here, to prevent any confuſion of voluntary, with ſenſitive, or aſſociate motions, that in all the inſtances of violent efforts to relieve pain, thoſe efforts are at firſt voluntary exertions; but after they have been frequently repeated for the purpoſe of relieving certain pains, they become aſſociated with thoſe pains, and ceaſe at thoſe times to be ſubſervient to the will; as in coughing, ſneezing, and ſtrangury. Of theſe motions thoſe which contribute to remove or diſlodge the offending cauſe, as the actions of the abdominal muſcles in parturition or in vomiting, though they were originally excited by volition, are in this work termed ſenſitive motions; but thoſe actions of the muſcles or organs of ſenſe, which do not contribute to remove the offending cauſe, as in general convulſions or in madneſs are in this work termed voluntary motions, or motions in conſequence of averſion, though in common language they are called involuntary ones. Thoſe ſenſitive unreſtrainable actions,

actions, which contribute to remove the cauſe of pain are uniformly and invariably exerted, as in coughing or ſneezing; but thoſe motions which are exerted in conſequence of averſion without contributing to remove the painful cauſe, but only to prevent the ſenſation of it, as in epileptic, or cataleptic fits, are not uniformly and invariably exerted, but change from one ſet of muſcles to another, as will be further explained; and may by this criterion alſo be diſtinguiſhed from the former.

At the ſame time thoſe motions, which are excited by perpetual ſtimulus, or by aſſociation with each other, or immediately by pleaſurable or painful ſenſation, may properly be termed involuntary motions, as thoſe of the heart and arteries; as the faculty of volition ſeldom affects thoſe, except when it exiſts in unnatural quantity, as in maniacal people.

2. It was obſerved in Section IV. on the Production of Ideas, that thoſe parts of the ſyſtem, which are uſually termed the organs of ſenſe, are liable to be excited into pain by the exceſs of the ſtimulus of thoſe objects, which are by nature adapted to affect them; as of too great light, ſound, or preſſure. But that theſe organs receive no pain from the defect or abſence of theſe ſtimuli, as in darkneſs or ſilence. But that our other organs of perception, which have generally been called appetites, as of hunger, thirſt, want of heat, want of freſh air, are liable to be affected with pain by the defect, as well as by the exceſs of their appropriated ſtimuli.

This exceſs or defect of ſtimulus is however to be conſidered only as the remote cauſe of the pain, the immediate cauſe being the exceſs or defect of the natural action of the affected part, according to Sect. IV. 5. Hence all the pains of the body may be

be divided into thoſe from exceſs of motion, and thoſe from defect of motion; which diſtinction is of great importance in the knowledge and the cure of many diſeaſes. For as the pains from exceſs of motion either gradually ſubſide, or are in general ſucceeded by inflammation; ſo thoſe from defect of motion either gradually ſubſide, or are in general ſucceeded by convulſion, or madneſs. Theſe pains are eaſily diſtinguiſhable from each other by this circumſtance, that the former are attended with heat of the pained part, or of the whole body; whereas the latter exiſts without increaſe of heat in the pained part, and is generally attended with coldneſs of the extremities of the body; which is the true criterion of what have been called nervous pains.

Thus when any acrid material, as ſnuff or lime, falls into the eye, pain and inflammation and heat are produced from the exceſs of ſtimulus; but violent hunger, hemicrania, or the clavus hyſtericus, are attended with coldneſs of the extremities, and defect of circulation. When we are expoſed to great cold, the pain we experience from the deficiency of heat is attended with a quieſcence of the motions of the vaſcular ſyſtem; ſo that no inflammation is produced, but a great deſire of heat, and a tremulous motion of the ſubcutaneous muſcles, which is properly a convulſion in conſequence of this pain from defect of the ſtimulus of heat.

It was before mentioned, that as ſenſation conſiſts in certain movements of the ſenſorium, beginning at ſome of the extremities of it, and propagated to the central parts of it; ſo volition conſiſts of certain other movements of the ſenſorium, commencing in the central parts of it, and propagated to ſome of its extremities. This idea of theſe two great powers of motion in the animal machine is confirmed from obſerving, that they never

ver exiſt in a great degree or univerſally at the ſame time; for while we ſtrongly exert our voluntary motions, we ceaſe to feel the pains or uneaſineſſes, which occaſioned us to exert them.

Hence during the time of fighting with fiſts or ſwords no pain is felt by the combatants, till they ceaſe to exert themſelves. Thus in the beginning of ague-fits the painful ſenſation of cold is diminiſhed, while the patient exerts himſelf in the ſhivering and gnaſhing of his teeth. He then ceaſes to exert himſelf, and the pain of cold returns; and he is thus perpetually induced to reiterate theſe exertions, from which he experiences a temporary relief. The ſame occurs in labour-pains, the exertion of the parturient woman relieves the violence of the pains for a time, which recur again ſoon after ſhe has ceaſed to uſe thoſe exertions. The ſame is true in many other painful diſeaſes, as in the ſtrangury, teneſmus, and the efforts of vomiting; all theſe diſagreeable ſenſations are diminiſhed or removed for a time by the various exertions they occaſion, and recur alternately with thoſe exertions.

The reſtleſſneſs in ſome fevers is an almoſt perpetual exertion of this kind, excited to relieve ſome diſagreeable ſenſations; the reciprocal oppoſite exertions of a wounded worm, the alternate emproſthotonos and opiſthotonos of ſome ſpaſmodic diſeaſes, and the intervals of all convulſions, from whatever cauſe, ſeem to be owing to this circumſtance of the laws of animation; that great or univerſal exertion cannot exiſt at the ſame time with great or univerſal ſenſation, though they can exiſt reciprocally; which is probably reſolvable into the more general law, that the whole ſenſorial power being expended in one mode of exertion, there is none to ſpare for any other. Whence ſyncope, or temporary apoplexy, ſucceeds to epileptic convulſions.

3. Hence

3. Hence when any violent pain afflicts us, of which we can neither avoid nor remove the cauſe, we ſoon learn to endeavour to alleviate it, by exerting ſome violent voluntary effort, as mentioned above; and are naturally induced to uſe thoſe muſcles for this purpoſe, which have been in the early periods of our lives moſt frequently or moſt powerfully exerted.

Now the firſt muſcles, which infants uſe moſt frequently, are thoſe of reſpiration; and on this account we gain a habit of holding our breath, at the ſame time that we uſe great efforts to exclude it, for this purpoſe of alleviating unavoidable pain; or we preſs out our breath through a ſmall aperture of the larynx, and ſcream violently, when the pain is greater than is relievable by the former mode of exertion. Thus children ſcream to relieve any pain either of body or mind, as from anger, or fear of being beaten.

Hence it is curious to obſerve, that thoſe animals, who have more frequently exerted their muſcles of reſpiration violently, as in talking, barking, or grunting, as children, dogs, hogs, ſcream much more, when they are in pain, than thoſe other animals, who uſe little or no language in their common modes of life; as horſes, ſheep, and cows.

The next moſt frequent or moſt powerful efforts, which infants are firſt tempted to produce, are thoſe with the muſcles in biting hard ſubſtances; indeed the exertion of theſe muſcles is very powerful in common maſtication, as appears from the pain we receive, if a bit of bone is unexpectedly found amongſt our ſofter food; and further appears from their acting to ſo ſo great mechanical diſadvantage, particularly when we bite with the inciſores, or canine teeth, which are firſt formed, and thence are firſt uſed to violent exertion.

Hence

Hence when a perſon is in great pain, the cauſe of which he cannot remove, he ſets his teeth firmly together, or bites ſome ſubſtance between them with great vehemence, as another mode of violent exertion to produce a temporary relief. Thus we have a proverb where no help can be had in pain, "to grin and abide;" and the tortures of hell are ſaid to be attended with "gnaſhing of teeth."

Hence in violent ſpaſmodic pains I have ſeen people bite not only their tongues, but their arms or fingers, or thoſe of the attendants, or any object which was near them; and alſo ſtrike, pinch, or tear, others or themſelves, particularly the part of their own body, which is painful at the time. Soldiers, who die of painful wounds in battle, are ſaid in Homer to bite the ground. Thus alſo in the bellon, or colica ſaturnina, the patients are ſaid to bite their own fleſh, and dogs in this diſeaſe to bite up the ground they lie upon. It is probable that the great endeavours to bite in mad dogs, and the violence of other mad animals, is owing to the ſame cauſe.

4. If the efforts of our voluntary motions are exerted with ſtill greater energy for the relief of ſome diſagreeable ſenſation, convulſions are produced; as the various kinds of epilepſy, and in ſome hyſteric paroxyſms. In all theſe diſeaſes a pain or diſagreeable ſenſation is produced, frequently by worms, or acidity in the bowels, or by a diſeaſed nerve in the ſide, or head, or by the pain of a diſeaſed liver.

In ſome conſtitutions a more intolerable degree of pain is produced in ſome part at a diſtance from the cauſe by ſenſitive aſſociation, as before explained; theſe pains in ſuch conſtitutions ariſe to ſo great a degree, that I verily believe no artificial tortures could equal ſome, which I have witneſſed; and am confident life would not have long been preſerved, unleſs

unleſs they had been ſoon diminiſhed or removed by the univerſal convulſion of the voluntary motions, or by temporary madneſs.

In ſome of the unfortunate patients I have obſerved, the pain has riſen to an inexpreſſible degree, as above deſcribed, before the convulſions have ſupervened; and which were preceded by ſcreaming, and grinning; in others, as in the common epilepſy, the convulſion has immediately ſucceeded the commencement of the diſagreeable ſenſations; and as a ſtupor frequently ſucceeds the convulſions, they only ſeemed to remember that a pain at the ſtomach preceded the fit, or ſome other uneaſy feel; or more frequently retained no memory at all of the immediate cauſe of the paroxyſm. But even in this kind of epilepſy, where the patient does not recollect any preceding pain, the paroxyſms generally are preceded by a quivering motion of the under jaw, with a biting of the tongue; the teeth afterwards become preſſed together with vehemence, and the eyes are then convulſed, before the commencement of the univerſal convulſion; which are all efforts to relieve pain.

The reaſon why theſe convulſive motions are alternately exerted and remitted, was mentioned above, and in Sect. XII. 1. 3. when the exertions are ſuch as give a temporary relief to the pain, which excites them, they ceaſe for a time, till the pain is again perceived; and then new exertions are produced for its relief. We ſee daily examples of this in the loud reiterated laughter of ſome people; the pleaſurable ſenſation, which excites this laughter, ariſes for a time ſo high as to change its name and become painful: the convulſive motions of the reſpiratory muſcles relieve the pain for a time; we are, however, unwilling to loſe the pleaſure, and preſently put a ſtop to this exertion, and immediately the pleaſure recurs, and again as inſtantly riſes into

into pain. All of us have felt the pain of immoderate laughter; children have been tickled into convulsions of the whole body; and others have died in the act of laughing; probably from a paralysis succeeding the long continued actions of the muscles of respiration.

Hence we learn the reason, why children, who are so easily excited to laugh by the tickling of other people's fingers, cannot tickle themselves into laughter. The exertion of their hands in the endeavour to tickle themselves prevents the necessity of any exertion of the respiratory muscles to relieve the excess of pleasurable affection. See Sect. XVII. 3. 5.

Chrysippus is recorded to have died laughing, when an ass was invited to sup with him. The same is related of one of the popes, who, when he was ill, saw a tame monkey at his bedside put on the holy tiara. Hall. Phys. T. III. p. 306.

There are instances of epilepsy being produced by laughing recorded by Van Swieten, T. III. 402 and 308. And it is well known, that many people have died instantaneously from the painful excess of joy, which probably might have been prevented by the exertions of laughter.

Every combination of ideas, which we attend to, occasions pain or pleasure; those which occasion pleasure, furnish either social or selfish pleasure, either malicious or friendly, or lascivious, or sublime pleasure; that is, they give us pleasure mixed with other emotions, or they give us unmixed pleasure, without occasioning any other emotions or exertions at the same time. This unmixed pleasure, if it be great, becomes painful, like all other animal motions from stimuli of every kind; and if no other exertions are occasioned at the same time, we use the exertion of laughter to relieve this pain. Hence laughter is occasioned by such wit as excites simple pleasure without any other emotion, such as pity, love,

love, reverence. For ſublime ideas are mixed with admiration, beautiful ones with love, new ones with ſurpriſe; and theſe exertions of our ideas prevent the action of laughter from being neceſſary to relieve the painful pleaſure above deſcribed. Whence laughable wit conſiſts of frivolous ideas, without connections of any conſequence, ſuch as puns on words, or on phraſes, incongruous junctions of ideas; on which account laughter is ſo frequent in children.

Unmixed pleaſure leſs than that, which cauſes laughter, cauſes ſleep, as in ſinging children to ſleep, or in ſlight intoxication from wine or food. See Sect. XVIII. 12.

5. If the pains, or diſagreeable ſenſations, above deſcribed, do not obtain a temporary relief from theſe convulſive exertions of the muſcles, thoſe convulſive exertions continue without remiſſion, and one kind of catalepſy is produced. Thus when a nerve or tendon produces great pain by its being inflamed or wounded, the patient ſets his teeth firmly together, and grins violently, to diminiſh the pain; and if the pain is not relieved by this exertion, no relaxation of the maxillary muſcles takes place, as in the convulſions above deſcribed, but the jaws remain firmly fixed together. This locked jaw is the moſt frequent inſtance of cataleptic ſpaſm, becauſe we are more inclined to exert the muſcles ſubſervient to maſtication from their early obedience to violent efforts of volition.

But in the caſe related in Sect. XIX. on Reverie, the cataleptic lady had pain in her upper teeth; and preſſing one of her hands vehemently againſt her cheek-bone to diminiſh this pain, it remained in that attitude for about half an hour twice a day, till the painful paroxyſm was over.

I have this very day ſeen a young lady in this diſeaſe, (with which ſhe has frequently been afflicted,) ſhe began to-day with violent pain ſhooting from one

one ſide of the forehead to the occiput, and after various ſtruggles lay on the bed with her fingers and wriſts bent and ſtiff for about two hours; in other reſpects ſhe ſeemed in a ſyncope with a natural pulſe. She then had intervals of pain and of ſpaſm, and took three grains of opium every hour till ſhe had taken nine grains, before the pains and ſpaſm ceaſed.

There is, however, another ſpecies of fixed ſpaſm, which differs from the former, as the pain exiſts in the contracted muſcle, and would ſeem rather to be the conſequence than the cauſe of the contraction, as in the cramp in the calf of the leg, and in many other parts of the body.

In theſe ſpaſms it ſhould ſeem, that the muſcle itſelf is firſt thrown into contraction by ſome diſagreeable ſenſation, as of cold; and that then the violent pain is produced by the great contraction of the muſcular fibres extending its own tendons, which are ſaid to be ſenſible to extenſion only; and is further explained in Sect. XVIII. 15.

6. Many inſtances have been given in this work, where after violent motions excited by irritation, the organ has become quieſcent to leſs, and even to the great irritation, which induced it into violent motion; as after looking long at the ſun or any bright colour, they ceaſe to be ſeen; and after removing from bright day-light into a gloomy room, the eye cannot at firſt perceive the objects, which ſtimulate it leſs. Similar to this is the ſyncope, which ſucceeds after the violent exertions of our voluntary motions, as after epileptic fits, for the power of volition acts in this caſe as the ſtimulus in the other. This ſyncope is a temporary palſy, or apoplexy, which ceaſes after a time, the muſcles recovering their power of being excited into action by the efforts of volition; as the eye in the circumſtance above mentioned recovers in a little time its power of ſeeing objects in a gloomy room, which were

were inviſible immediately after coming out of a ſtronger light. This is owing to an accumulation of ſenſorial power during the inaction of thoſe fibres, which were before accuſtomed to perpetual exertions, as explained in Sect. XII. 7. 1. A ſlighter degree of this diſeaſe is experienced by every one after great fatigue, when the muſcles gain ſuch inability to further action, that we are obliged to reſt them for a while, or to ſummon a greater power of volition to continue their motions.

In all the ſyncopes, which I have ſeen induced after convulſive fits, the pulſe has continued natural, though the organs of ſenſe, as well as the locomotive muſcles, have ceaſed to perform their functions; for it is neceſſary for the perception of objects, that the external organs of ſenſe ſhould be properly excited by the voluntary power, as the eyelids muſt be open, and perhaps the muſcles of the eye put into action to diſtend, and thence give greater pellucidity to the cornea, which in ſyncope, as in death, appears flat and leſs tranſparent. The tympanum of the ear alſo ſeems to require a voluntary exertion of its muſcles, to gain its due tenſion, and it is probable the other external organs of ſenſe require a ſimilar voluntary exertion to adapt them to the diſtinct perception of objects. Hence in ſyncope as in ſleep, as the power of volition is ſuſpended, no external objects are perceived. See Sect. XVIII. 5. During the time which the patient lies in a fainting fit, the ſpirit of animation becomes accumulated; and hence the muſcles in a while become irritable by their uſual ſtimulation, and the fainting fit ceaſes. See Sect. XII. 7. 1.

7. If the exertion of the voluntary motions has been ſtill more energetic, the quieſcence, which ſucceeds, is ſo complete, that they cannot again be excited into action by the efforts of the will. In this manner the palſy, and apoplexy (which is an

univerſal palſy) are frequently produced after convulſions, or other violent exertions; of this I ſhall add a few inſtances.

Platernus mentions ſome, who have died apoplectic from violent exertions in dancing; and Dr. Mead, in his Eſſay on Poiſons, records a patient in the hydrophobia, who at one effort broke the cords which bound him, and at the ſame inſtant expired. And it is probable, that thoſe, who have expired from immoderate laughter, have died from this paralyſis conſequent to violent exertion. Mrs. Scott of Stafford was walking in her garden in perfect health with her neighbour Mrs. ——; the latter accidentally fell into a muddy rivulet, and tried in vain to diſengage herſelf by the aſſiſtance of Mrs. Scott's hand. Mrs. Scott exerted her utmoſt power for many minutes, firſt to aſſiſt her friend, and next to prevent herſelf from being pulled into the moraſs, as her diſtreſſed companion would not diſengage her hand. After other aſſiſtance was procured by their united ſcreams, Mrs. Scott walked to a chair about twenty yards from the brook, and was ſeized with an apoplectic ſtroke: which continued many days, and terminated in a total loſs of her right arm, and her ſpeech; neither of which ſhe ever after perfectly recovered.

It is ſaid, that many people in Holland have died after ſkating too long or too violently on their frozen canals; it is probable the death of theſe, and of others, who have died ſuddenly in ſwimming, has been owing to this great quieſcence or paralyſis; which has ſucceeded very violent exertions, added to the concomitant cold, which has had greater effect after the ſufferers had been heated and exhauſted by previous exerciſe.

I remember a young man of the name of Nairne at Cambridge, who walking on the edge of a barge fell into the river. His couſin and fellow-ſtudent of the

the ſame name, knowing the other could not ſwim, plunged into the water after him, caught him by his clothes, and approaching the bank by a vehement exertion propelled him ſafe to the land, but that inſtant, ſeized, as was ſuppoſed, by the cramp, or paralyſis, ſunk to riſe no more. The reaſon why the cramp of the muſcles, which compoſe the calf of the leg, is ſo liable to affect ſwimmers, is, becauſe theſe muſcles have very weak antagoniſts, and are in walking generally elongated again after their contraction by the weight of the body on the ball of the toe, which is very much greater than the reſiſtance of the water in ſwimming. See Section XVIII. 15.

It does not follow that every apoplectic or paralytic attack is immediately preceded by vehement exertion; the quieſcence, which ſucceeds exertion, and which is not ſo great as to be termed paralyſis, frequently recurs afterwards at certain periods; and by other cauſes of quieſcence, occurring with thoſe periods, as was explained in treating of the paroxyſms of intermitting fevers; the quieſcence at length becomes ſo great as to be incapable of again being removed by the efforts of volition, and complete paralyſis is formed. See Section XXXII. 3. 2.

Many of the paralytic patients, whom I have ſeen, have evidently had diſeaſed livers from the too frequent potation of ſpirituous liquors; ſome of them have had the gutta roſea on their faces and breaſts; which has in ſome degree receded either ſpontaneouſly, or by the uſe of external remedies, and the paralytic ſtroke has ſucceeded; and as in ſeveral perſons, who have drank much vinous ſpirits, I have obſerved epileptic fits to commence at about forty or fifty years of age, without any hereditary taint, from the ſtimulus, as I believed, of a diſeaſed liver; I was induced to aſcribe many paralytic caſes to the ſame ſource; which were not evidently the effect

of age, or of unacquired debility. And the account given before of dropſies, which very frequently are owing to a paralyſis of the abſorbent ſyſtem, and are generally attendant on free drinkers of ſpirituous liquors, confirmed me in this opinion.

The diſagreeable irritation of a diſeaſed liver produces exertions and conſequent quieſcence; theſe by the accidental concurrence of other cauſes of quieſcence, as cold, ſolar or lunar periods, inanition, the want of their uſual portion of ſpirit of wine, at length produces paralyſis.

This is further confirmed by obſerving, that the muſcles, we moſt frequently, or moſt powerfully exert, are moſt liable to palſy; as thoſe of the voice and of articulation, and of thoſe paralytics which I have ſeen, a much greater proportion have loſt the uſe of their right arm; which is ſo much more generally exerted than the left.

I cannot diſmiſs this ſubject without obſerving, that after a paralytic ſtroke, if the vital powers are not much injured, the patient has all the movements of the affected limb to learn over again, juſt as in early infancy; the limb is firſt moved by the irritation of its muſcles, as in ſtretching, (of which a caſe was related in Section VII. 1. 3.) or by the electric concuſſion; afterwards it becomes obedient to ſenſation, as in violent danger or fear; and laſtly, the muſcles become again aſſociated with volition, and gradually acquire their uſual habits of acting together.

Another phænomenon in palſies is, that when the limbs of one ſide are diſabled, thoſe of the other are in perpetual motion. This can only be explained from conceiving that the power of motion, whatever it is, or wherever it reſides, and which is capable of being exhauſted by fatigue, and accumulated in reſt, is now leſs expended, whilſt one half of the body is capable of receiving its due proportion

tion of it, and is hence derived with greater eaſe or in greater abundance into the limbs, which remain unaffected.

II. 1. The exceſs or defect of voluntary exertion produces ſimilar effects upon the ſenſual motions, or ideas of the mind, as thoſe already mentioned upon the muſcular fibres. Thus when any violent pain, ariſing from the defect of ſome peculiar ſtimulus, exiſts either in the muſcular or ſenſual ſyſtems of fibres, and which cannot be removed by acquiring the defective ſtimulus; as in ſome conſtitutions convulſions of the muſcles are produced to procure a temporary relief, ſo in other conſtitutions vehement voluntary exertions of the ideas of the mind are produced for the ſame purpoſe; for during this exertion, like that of the muſcles, the pain either vaniſhes or is diminiſhed: this violent exertion conſtitutes madneſs; and in many caſes I have ſeen the madneſs take place, and the convulſions ceaſe, and reciprocally the madneſs ceaſe, and the convulſions ſupervene. See Sect. III. 5. 8.

2. Madneſs is diſtinguiſhable from delirium, as in the latter the patient knows not the place where he reſides, nor the perſons of his friends or attendants, nor is conſcious of any external objects, except when ſpoken to with a louder voice, or ſtimulated with unuſual force, and even then he ſoon relapſes into a ſtate of inattention to every thing about him. Whilſt in the former he is perfectly ſenſible to every thing external, but has the voluntary powers of his mind intenſely exerted n ſome particular object of his deſire or averſion, he harbours in his thoughts a ſuſpicion of all mankind, leſt they ſhould counteract his deſigns; and while he keeps his intentions and the motives of his actions profoundly ſecret; he is perpetually ſtudying the means of acquiring the object of his wiſh, or of preventing or revenging the injuries he ſuſpects.

3. A late French philoſopher, Mr. Helvetius, has deduced almoſt all our actions from this principle of their relieving us from the ennui or tædium vitæ; and true it is, that our deſires or averſions are the motives of all our voluntary actions; and human nature ſeems to excel other animals in the more facil uſe of this voluntary power, and on that account is more liable to inſanity than other animals. But in mania this violent exertion of volition is expended on miſtaken objects, and would not be relieved, though we were to gain or eſcape the objects, that excite it. Thus I have ſeen two inſtances of madmen, who conceived that they had the itch, and ſeveral have believed they had the venereal infection, without in reality having a ſymptom of either of them. They have been perpetually thinking upon this ſubject, and ſome of them were in vain ſalivated with deſign of convincing them to the contrary.

4. In the minds of mad people thoſe volitions alone exiſt, which are unmixed with ſenſation; immoderate ſuſpicion is generally the firſt ſymptom, and want of ſhame, and want of delicacy about cleanlineſs. Suſpicion is a voluntary exertion of the mind, ariſing from the pain of fear, which it is exerted to relieve: ſhame is the name of a peculiar diſagreeable ſenſation, ſee Fable of the Bees, and delicacy about cleanlineſs ariſes from another diſagreeable ſenſation. And therefore are not found in the minds of maniacs, which are employed ſolely in voluntary exertions. Hence the moſt modeſt women in this diſeaſe walk naked amongſt men without any kind of concern, uſe obſcene diſcourſe, and have no delicacy about their natural evacuations.

5. Nor are maniacal people more attentive to their natural appetites, or to the irritations which ſurround them, except as far as may reſpect their ſuſpicions or deſigns; for the violent and perpetual exertions

exertions of their voluntary powers of mind prevent their perception of almoſt every other object, either of irritation or of ſenſation. Hence it is that they bear cold, hunger, and fatigue, with much greater pertinacity than in their ſober hours, and are leſs injured by them in reſpect to their general health. Thus it is aſſerted by hiſtorians, that Charles the Twelfth of Sweden ſlept on the ſnow, wrapped only in his cloak, at the ſiege of Frederickſtad, and bore extremes of cold, and hunger, and fatigue, under which numbers of his ſoldiers periſhed; becauſe the king was inſane with ambition, but the ſoldier had no ſuch powerful ſtimulus to preſerve his ſyſtem from debility and death.

6. Beſides the inſanities ariſing from exertions in conſequence of pain, there is alſo a pleaſurable inſanity, as well as a pleaſurable delirium; as the inſanity of perſonal vanity, and that of religious fanaticiſm. When agreeable ideas excite into motion the ſenſorial power of ſenſation, and this again cauſes other trains of agreeable ideas, a conſtant ſtream of pleaſurable ideas ſucceeds, and produces pleaſurable delirium. So when the ſenſorial power of volition excites agreeable ideas, and the pleaſure thus produced excites more volition in its turn, a conſtant flow of agreeable voluntary ideas ſucceeds; which when thus exerted in the extreme conſtitutes inſanity.

Thus when our muſcular actions are excited by our ſenſations of pleaſure, it is termed play; when they are excited by our volition, it is termed work; and the former of theſe is attended with leſs fatigue, becauſe the muſcular actions in play produce in their turn more pleaſurable ſenſation; which again has the property of producing more muſcular action. An agreeable inſtance of this I ſaw this morning. A little boy, who was tired with walking, begged of his papa to carry him. "Here," ſays

ſays the reverend doctor, " ride upon my gold-headed cane;" and the pleaſed child, putting it between his legs, galloped away with delight, and complained no more of his fatigue. Here the aid of another ſenſorial power, that of pleaſurable ſenſation, ſuperadded vigour to the exertion of exhauſted volition. Which could otherwiſe only have been excited by additional pain, as by the laſh of ſlavery. On this account, where the whole ſenſorial power has been exerted on the contemplation of the promiſed joys of heaven, the ſaints of all perſecuted religions have borne the tortures of martyrdom with otherwiſe unaccountable firmneſs.

7. There are ſome diſeaſes, which obtain at leaſt a temporary relief from the exertions of inſanity; many inſtances of dropſies being thus for a time cured are recorded. An elderly woman labouring with aſcites I twice ſaw relieved for ſome weeks by inſanity, the dropſy ceaſed for ſeveral weeks, and recurred again, alternating with the inſanity. A man afflicted with difficult reſpiration on lying down, with very irregular pulſe, and œdematous legs, whom I ſaw this day, has for above a week been much relieved in reſpect to all thoſe ſymptoms by the acceſſion of inſanity, which is ſhewn by inordinate ſuſpicion, and great anger.

In caſes of common temporary anger the increaſed action of the arterial ſyſtem is ſeen by the red ſkin, and increaſed pulſe, with the immediate increaſe of muſcular activity. A friend of mine, when he was painfully fatigued by riding on horſeback, was accuſtomed to call up ideas into his mind, which uſed to excite his anger or indignation, and thus for a time at leaſt relieved the pain of fatigue. By this temporary inſanity, the effect of the voluntary power upon the whole of his ſyſtem was increaſed; as in the caſes of dropſy above mentioned, it would appear, that the increaſed action of the

voluntary

voluntary faculty of the ſenſorium affected the abſorbent ſyſtem, as well as the ſecerning one.

8. In reſpect to relieving inflammatory pains, and removing fever, I have ſeen many inſtances, as mentioned in Sect. XII. 2. 4. One lady, whom I attended, had twice at ſome years interval a locked jaw, which relieved a pain on her ſternum with peripneumony. Two other ladies I ſaw, who towards the end of violent peripneumony, in which they frequently loſt blood, were at length cured by inſanity ſupervening. In the former the increaſed voluntary exertion of the muſcles of the jaw, in the latter that of the organs of ſenſe, removed the diſeaſe; that is, the diſagreeable ſenſation, which had produced the inflammation, now excited the voluntary power, and theſe new voluntary exertions employed or expended the ſuperabundant ſenſorial power, which had previouſly been exerted on the arterial ſyſtem, and caufed inflammation.

Another caſe, which I think worth relating, was of a young man about twenty; he had laboured under an irritative fever with debility for three or four weeks, with very quick and very feeble pulſe, and other uſual ſymptoms of that ſpecies of typhus, but at this time complained much and frequently of pain of his legs and feet. When thoſe who attended him were nearly in deſpair of his recovery, I obſerved with pleaſure an inſanity of mind ſupervene: which was totally different from delirium, as he knew his friends, calling them by their names, and the room in which he lay, but became violently ſuſpicious of his attendants, and calumniated with vehement oaths his tender mother, who ſat weeping by his bed. On this his pulſe became ſlower and firmer, but the quickneſs did not for ſome time intirely ceaſe, and he gradually recovered. In this caſe the introduction of an increaſed quantity of the power of volition gave vigour to thoſe movements

movements of the ſyſtem, which are generally only actuated by the power of irritation, and of aſſociation.

Another caſe I recollect of a young man, about twenty-five, who had the ſcarlet-fever, with very quick pulſe, and an univerſal eruption on his ſkin, and was not without reaſon eſteemed to be in great danger of his life. After a few days an inſanity ſupervened, which his friends miſtook for delirium, and he gradually recovered, and the cuticle peeled off. From theſe and a few other caſes I have always eſteemed inſanity to be a favourable ſign in fevers, and have cautiouſly diſtinguiſhed it from delirium.

III. Another mode of mental exertion to relieve pain, is by producing a train of ideas not only by the efforts of volition, as in inſanity; but by thoſe of ſenſation likewiſe, as in delirium and ſleep. This mental effort is termed reverie, or ſomnambulation, and is deſcribed more at large in Sect. XIX. on that ſubject. But I ſhall here relate another caſe of that wonderful diſeaſe, which fell yeſterday under my eye, and to which I have ſeen many analogous alienations of mind, though not exactly ſimilar in all circumſtances. But as all of them either began or terminated with pain or convulſion, there can be no doubt but that they are of epileptic origin, and conſtitute another mode of mental exertion to relieve ſome painful ſenſation.

1. Maſter A. about nine years old, had been ſeized at ſeven every morning for ten days with uncommon fits, and had had ſlight returns in the afternoon. They were ſuppoſed to originate from worms, and had been in vain attempted to be removed by vermifuge purges. As his fit was expected at ſeven yeſterday morning, I ſaw him before that hour; he was aſleep, ſeemed free from pain, and his pulſe natural. About ſeven he began to complain of pain about his navel, or more to the left ſide, and in a

few

few minutes had exertions of his arms and legs like ſwimming. He then for half an hour hunted a pack of hounds; as appeared by his hallooing, and calling the dogs by their names, and diſcourſing with the attendants of the chaſe, deſcribing exactly a day of hunting, which (I was informed) he had witneſſed a year before, going through all the moſt minute circumſtances of it; calling to people, who were then preſent, and lamenting the abſence of others, who were then alſo abſent. After this ſcene he imitated, as he lay in bed, ſome of the plays of boys, as ſwimming and jumping. He then ſung an Engliſh and then an Italian ſong; part of which with his eyes open, and part with them cloſed, but could not be awakened or excited by any violence, which it was proper to uſe.

After about an hour he came ſuddenly to himſelf with apparent ſurpriſe, and ſeemed quite ignorant of any part of what had paſſed, and after being apparently well for half an hour, he ſuddenly fell into a great ſtupor, with ſlower pulſe than natural, and a ſlow moaning reſpiration, in which he continued about another half hour, and then recovered.

The ſequel of this diſeaſe was favourable; he was directed one grain of opium at ſix every morning, and then to riſe out of bed; at half paſt ſix he was directed fifteen drops of laudanum in a glaſs of wine and water. The firſt day the paroxyſm became ſhorter, and leſs violent. The doſe of opium was increaſed to one-half more, and in three or four days the fits left him. The bark and filings of iron were alſo exhibited twice a day; and I believe the complaint returned no more.

2. In this paroxyſm it muſt be obſerved, that he began with pain, and ended with ſtupor, in both circumſtances reſembling a fit of epilepſy. And that therefore the exertions both of mind and body, both the voluntary ones, and thoſe immediately excited

cited by pleaſurable ſenſation, were exertions to relieve pain.

The hunting ſcene appeared to be rather an act of memory than of imagination, and was therefore rather a voluntary exertion, though attended with the pleaſurable eagerneſs, which was the conſequence of thoſe ideas recalled by recollection, and not the cauſe of them.

Theſe ideas thus voluntarily recollected were ſucceeded by ſenſations of pleaſure, though his ſenſes were unaffected by the ſtimuli of viſible or audible objects; or ſo weakly excited by them as not to produce ſenſation or attention. And the pleaſure thus excited by volition produced other ideas and other motions in conſequence of the ſenſorial power of ſenſation. Whence the mixed catenations of voluntary and ſenſitive ideas and muſcular motions in reverie; which, like every other kind of vehement exertion, contribute to relieve pain, by expending a large quantity of ſenſorial power.

Thoſe fits generally commence during ſleep, from whence I ſuppoſe they have been thought to have ſome connection with ſleep, and have thence been termed Somnambuliſm; but their commencement during ſleep is owing to our increaſed excitability by internal ſenſations at that time, as explained in Sect. XVIII. 14 and 15, and not to any ſimilitude between reverie and ſleep.

3. I was once concerned for a very elegant and ingenious young lady, who had a reverie on alternate days, which continued nearly the whole day; and as in her days of diſeaſe ſhe took up the ſame kind of ideas, which ſhe had converſed about on the alternate day before, and could recollect nothing of them on her well-day; ſhe appeared to her friends to poſſeſs two minds. This caſe alſo was of epileptic kind, and was cured, with ſome relapſes, by opium

opium adminiſtered before the commencement of the paroxyſm.

4. Whence it appears, that the methods of relieving inflammatory pains, is by removing all ſtimulus, as by veneſection, cool air, mucilaginous diet, aqueous potation, ſilence, darkneſs.

The methods of relieving pains from defect of ſtimulus is by ſupplying the peculiar ſtimulus required, as of food, or warmth.

And the general method of relieving pain is by exciting into action ſome great part of the ſyſtem for the purpoſe of expending a part of the ſenſorial power. This is done either by the exertion of the voluntary ideas and muſcles, as in inſanity and convulſion; or by exerting both voluntary and ſenſitive motions, as in reverie; or by exciting the irritative motions by wine or opium internally, and by the warm bath or bliſters externally; or laſtly, by exciting the ſenſitive ideas by good news, affecting ſtories, or agreeable paſſions.

SECT.

SECT. XXXV.

DISEASES OF ASSOCIATION.

I. 1. *Sympathy or conſent of parts. Primary and ſecondary parts of an aſſociated train of motions reciprocally affect each other. Parts of irritative trains of motion affect each other in four ways. Sympathies of the ſkin and ſtomach, Fluſhing of the face after a meal. Eruption of the ſmall-pox on the face. Chillneſs after a meal.* 2. *Vertigo from intoxication.* 3. *Abſorption from the lungs and pericardium by emetics. In vomiting the actions of the ſtomach are decreaſed, not increaſed. Digeſtion ſtrengthened after an emetic. Vomiting from deficiency of ſenſorial power.* 4. *Dyſpnœa from cold bathing. Slow pulſe from digitalis. Death from gout in the ſtomach.* II. 1. *Primary and ſecondary parts of ſenſitive aſſociations affect each other. Pain from gall-ſtone, from urinary ſtone. Hemicrania. Painful epilepſy.* 2. *Gout and red face from inflamed liver. Shingles from inflamed kidney.* 3. *Coryza from cold applied to the feet. Pleuriſy, Hepatitis.* 4. *Pain of ſhoulders from inflamed liver.* III. *Diſeaſes from the aſſociations of ideas.*

I. 1. MANY ſynchronous and ſucceſſive motions of our muſcular fibres, and of our organs of ſenſe, or ideas, become aſſociated ſo as to form indiſſoluble tribes or trains of action, as ſhewn in Section X. on Aſſociate Motions. Some conſtitutions more eaſily eſtabliſh theſe aſſociations, whether by voluntary, ſenſitive, or irritative repetitions, and ſome more

more eaſily loſe them again, as ſhewn in Section XXXI. on Temperaments.

When the beginning of ſuch a train of actions becomes by any means diſordered, the ſucceeding part is liable to become diſturbed in conſequence, and this is commonly termed ſympathy or conſent of parts by the writers of medicine. For the more clear underſtanding of theſe ſympathies we muſt conſider a tribe or train of actions as divided into two parts, and call one of them the primary or original motions, and the other the ſecondary or ſympathetic ones.

The primary and ſecondary parts of a train of irritative actions may reciprocally affect each other in four different manners. 1. They may both be exerted with greater energy than natural. 2. The former may act with greater, and the latter with leſs energy. 3. The former may act with leſs, and the latter with greater energy. 4. They may both act with leſs energy than natural. I ſhall now give an example of each kind of theſe modes of action, and endeavour to ſhew, that though the primary and ſecondary parts of theſe trains or tribes of motion are connected by irritative aſſociation, or their previous habits of acting together, as deſcribed in Sect. XX. on Vertigo. Yet that their acting with ſimilar or diſſimilar degrees of energy, depends on the greater or leſs quantity of ſenſorial power, which the primary part of the train expends in its exertions.

The actions of the ſtomach conſtitute ſo important a part of the aſſociations of both irritative and ſenſitive motions, that it is ſaid to ſympathize with almoſt every part of the body; the firſt example, which I ſhall adduce to ſhew that both the primary and ſecondary parts of a train of irritative aſſociations of motion act with increaſed energy, is taken from the conſent of the ſkin with this organ. When the

the action of the fibres of the ſtomach is increaſed, as by the ſtimulus of a full meal, the exertions of the cutaneous arteries of the face become increaſed by their irritative aſſociations with thoſe of the ſtomach, and a glow or fluſhing of the face ſucceeds. For the ſmall veſſels of the ſkin of the face having been more accuſtomed to the varieties of action, from their frequent expoſure to various degrees of cold and heat become more eaſily excited into increaſed action, than thoſe of the covered parts of our bodies, and thus act with more energy from their irritative or ſenſitive aſſociations with the ſtomach. On this account in ſmall-pox the eruption in conſequence of the previous affection of the ſtomach breaks out a day ſooner on the face than on the hands, and two days ſooner than on the trunk, and recedes in ſimilar times after maturation.

But ſecondly, in weaker conſtitutions, that is, in thoſe who poſſeſs leſs ſenſorial power, ſo much of it is expended in the increaſed actions of the fibres of the ſtomach excited by the ſtimulus of a meal, that a ſenſe of chilneſs ſucceeds inſtead of the univerſal glow above mentioned; and thus the ſecondary part of the aſſociated train of motions is diminiſhed in energy, in conſequence of the increaſed activity of the primary part of it.

2. Another inſtance of a ſimilar kind, where the ſecondary part of the train acts with leſs energy in conſequence of the greater exertions of the primary part, is the vertigo attending intoxication; in this circumſtance ſo much ſenſorial power is expended on the ſtomach, and on its neareſt or more ſtrongly aſſociated motions, as thoſe of the ſubcutaneous veſſels, and probably of ths membranes of ſome internal viſcera, that the irritative motions of the retina become imperfectly exerted from deficiency of ſenſorial power, as explained in Sect. XX. and XXI. 3. on Vertigo and on Drunkenneſs, and hence the ſtaggering

gering inebriate cannot completely balance himſelf by ſuch indiſtinct viſion.

3. An inſtance of the third circumſtance, where the primary part of a train of irritative motions acts with leſs, and the ſecondary part with greater energy, may be obſerved by making the following experiment. If a perſon lies with his arms and ſhoulders out of bed, till they become cold, a temporary coryza or catarrh is produced; ſo that the paſſage of the noſtrils becomes totally obſtructed; at leaſt this happens to many people; and then on covering the arms and ſhoulders, till they become warm, the paſſage of the noſtrils ceaſes again to be obſtructed, and a quantity of mucus is diſcharged from them. In this caſe the quieſcence of the veſſels of the ſkin of the arms and ſhoulders, occaſioned by expoſure to cold air, produces by irritative aſſociation an increaſed action of the veſſels of the membrane of the noſtrils; and the accumulation of ſenſorial power during the torpor of the arms and ſhoulders is thus expended in producing a temporary coryza or catarrh.

Another inſtance may be adduced from the ſympathy or conſent of the motions of the ſtomach with other more diſtant links of the very extenſive tribes or trains of irritative motions aſſociated with them, deſcribed in Sect. XX. on Vertigo. When the actions of the fibres of the ſtomach are diminiſhed or inverted, the actions of the abſorbent veſſels, which take up the mucus from the lungs, pericardium, and other cells of the body, become increaſed, and abſorb the fluids accumulated in them with greater avidity, as appears from the exhibition of foxglove, antimony, or other emetics in caſes of anaſarca, attended with unequal pulſe and difficult reſpiration.

That the act of nauſea and vomiting is a decreaſed exertion of the fibres of the ſtomach may be thus deduced;

deduced; when an emetic medicine is adminiſtered, it produces the pain of ſickneſs, as a diſagreeable taſte in the mouth produces the pain of nauſea; theſe pains, like thoſe of hunger, or of cold, or like thoſe, which are uſually termed nervous, as the head-ach or hemicrania, do not excite the organ into greater action; but in this caſe I imagine the pains of ſickneſs or of nauſea counteract or deſtroy the pleaſurable ſenſation. which ſeems neceſſary to digeſtion, as ſhewn in Sect. XXXIII. 1. 1. The periſtaltic motions of the fibres of the ſtomach become enfeebled by the want of this ſtimulus of pleaſurable ſenſation, and in conſequence ſtop for a time, and then become inverted; for they cannot become inverted without being previouſly ſtopped. Now that this inverſion of the trains of motion of the fibres of the ſtomach is owing to the deficiency of pleaſurable ſenſation is evinced from this circumſtance, that a nauſeous idea excited by words will produce vomiting as effectually as a nauſeous drug.

Hence it appears, that the act of nauſea or vomiting expends leſs ſenſorial power than the uſual periſtaltic motions of the ſtomach in the digeſtion of our aliment; and that hence there is a greater quantity of ſenſorial power becomes accumulated in the fibres of the ſtomach, and more of it in conſequence to ſpare for the action of thoſe parts of the ſyſtem, which are thus aſſociated with the ſtomach, as of the whole abſorbent ſeries of veſſels, and which are at the ſame time excited by their uſual ſtimuli.

From this we can underſtand, how after the operation of an emetic the ſtomach becomes more irritable and ſenſible to the ſtimulus, and the pleaſure of food; ſince as the ſenſorial power becomes accumulated during the nauſea and vomiting, the digeſtive power is afterwards exerted more forcibly for a time. It ſhould, however, be here remarked,

that

that though vomiting is in general produced by the defect of this ſtimulus of pleaſurable ſenſation, as when a nauſeous drug is adminiſtered; yet in long continued vomiting, as in ſea-ſickneſs, or from habitual dram-drinking, it ariſes from deficiency of ſenſorial power, which in the former caſe is exhauſted by the increaſed exertion of the irritative ideas of viſion, and in the latter by the frequent application of an unnatural ſtimulus.

4. An example of the fourth circumſtance above mentioned, where both the primary and ſecondary parts of a train of motions proceed with energy leſs than natural, may be obſerved in the dyſpnœa, which occurs in going into a very cold bath, and which has been deſcribed and explained in Sect. XXXII. 3. 2.

And by the increaſed debility of the pulſations of the heart and arteries during the operation of an emetic. Secondly, from the ſlowneſs and intermiſſion of the pulſations of the heart from the inceſſant efforts to vomit occaſioned by an overdoſe of digitalis. And thirdly, from the total ſtoppage of the motions of the heart, or death, in conſequence of the torpor of the ſtomach, when affected with the commencement or cold paroxyſm of the gout. See Sect. XXV. 17.

II. 1. The primary and ſecondary parts of the trains of ſenſitive aſſociation reciprocally affect each other in different manners. 1. The increaſed ſenſation of the primary part may ceaſe, when that of the ſecondary part commences. 2. The increaſed action of the primary part may ceaſe, when that of the ſecondary part commences. 3. The primary part may have increaſed ſenſation, and the ſecondary part increaſed action. 4. The primary part may have increaſed action, and the ſecondary part increaſed ſenſation.

Examples of the firſt mode, where the increaſed ſenſation of the primary part of a train of ſenſitive aſſociation ceaſes, when that of the ſecondary part

commences, are not unfrequent; as this is the general origin of thoſe pains, which continue ſome time without being attended with inflammation, ſuch as the pain at the pit of the ſtomach from a ſtone at the neck of the gall-bladder, and the pain of ſtrangury in the glans penis from a ſtone at the neck of the urinary bladder. In both theſe caſes the part, which is affected ſecondarily, is believed to be much more ſenſible than the part primarily affected, as deſcribed in the catalogue of diſeaſes, Claſs II. 1. 1. 11. and IV. 2. 2. 2. and IV. 2. 2. 4.

The hemicrania, or nervous head-ach, as it is called, when it originates from a decaying tooth, is another diſeaſe of this kind; as the pain of the carious tooth always ceaſes, when the pain over one eye and temple commences. And it is probable, that the violent pains, which induce convulſions in painful epilepſies, are produced in the ſame manner, from a more ſenſible part ſympathizing with a diſeaſed one of leſs ſenſibility. See Catalogue of Diſeaſes, Claſs IV. 2. 2. 8. and III. 1. 1. 6.

The laſt tooth, or dens ſapientiæ, of the upper jaw moſt frequently decays firſt, and is liable to produce pain over the eye and temple of that ſide. The laſt tooth of the under jaw is alſo liable to produce a ſimilar hemicrania, when it begins to decay. When a tooth in the upper jaw is the cauſe of the headach, a ſlighter pain is ſometimes perceived on the cheek-bone. And when a tooth in the lower-jaw is the cauſe of headach, a pain ſometimes affects the tendons of the muſcles of the neck, which are attached near the jaws. But the clavus hyſtericus, or pain about the middle of the parietal bone on one ſide of the head, I have ſeen produced by the ſecond of the molares, or grinders, of the under jaw; of which I ſhall relate the following caſe. See Claſs IV. 2. 2. 8.

Mrs.

Mrs. ——, about 30 years of age, was ſeized with great pain about the middle of the right parietal bone, which had continued a whole day before I ſaw her, and was ſo violent as to threaten to occaſion convulſions. Not being able to detect a decaying tooth, or a tender one, by examination with my eye, or by ſtriking them with a tea-ſpoon, and fearing bad conſequences from her tendency to convulſion, I adviſed her to extract the laſt tooth of the under-jaw on the affected ſide; which was done without any good effect. She was then directed to loſe blood, and to take a briſk cathartic; and after that had operated, about 60 drops of laudanum were given her, with large doſes of bark; by which the pain was removed. In about a fortnight ſhe took a cathartic medicine by ill advice, and the pain returned with greater violence in the ſame place, and, before I could arrive, as ſhe lived 30 miles from me, ſhe ſuffered a paralytic ſtroke; which affected her limbs and her face on one ſide, and relieved the pain of her head.

About a year afterwards I was again called to her on account of a pain as violent as before, exactly on the ſame part of the other parietal bone. On examining her mouth I found the ſecond molaris of the under-jaw on the ſide before affected was now decayed, and concluded, that this tooth had occaſioned the ſtroke of the palſy by the pain and conſequent exertion it had cauſed. On this account I earneſtly entreated her to allow the ſound molaris of the ſame jaw oppoſite to the decayed one to be extracted; which was forthwith done, and the pain of her head immediately ceaſed, to the aſtoniſhment of her attendants.

In the caſes above related of the pain exiſting in a part diſtant from the ſeat of the diſeaſe, the pain is owing to defect of the uſual motions of the painful part. This appears from the coldneſs, paleneſs,

and emptineſs of the affected veſſels, or of the extremities of the body in general, and from there being no tendency to inflammation. The increaſed action of the primary part of theſe aſſociated motions, as of the hepatic termination of the bile-duct from the ſtimulus of a gall-ſtone, or of the interior termination of the urethra from the ſtimulus of a ſtone in the bladder, or laſtly, of a decaying tooth in hemicrania, deprives the ſecondary part of theſe aſſociated motions, namely, the exterior terminations of the bile-duct or urethra, or the pained membranes of the head in hemicrania, of their natural ſhare of ſenſorial power: and hence the ſecondary parts of theſe ſenſitive trains of aſſociation become pained from the deficiency of their uſual motions, which is accompanied with deficiency of ſecretions and of heat. See Sect. IV. 5. XII 5. 3. XXXIV. 1.

Why does the pain of the primary part of the aſſociation ceaſe, when that of the ſecondary part commences? This is a queſtion of intricacy, but perhaps not inexplicable. The pain of the primary part of theſe aſſociated trains of motion was owing to too great ſtimulus, as of the ſtone at the neck of the bladder, and was conſequently cauſed by too great action of the pained part This greater action than natural of the primary part of theſe aſſociated motions, by employing or expending the ſenſorial power of irritation belonging to the whole aſſociated train of motions, occaſioned torpor, and conſequent pain in the ſecondary part of the aſſociated train; which was poſſeſſed of greater ſenſibility than the primary part of it. Now the great pain of the ſecondary part of the train, as ſoon as it commences, employs or expends the ſenſorial power of ſenſation belonging to the whole aſſociated train of motions; and in conſequence the motions of the primary part, though increaſed by the ſtimulus

lus of an extraneous body, ceaſe to be accompanied with pain or ſenſation.

If this mode of reaſoning be juſt, it explains a curious fact, why when two parts of the body are ſtrongly ſtimulated, the pain is felt only in one of them, though it is poſſible by voluntary attention it may be alternately perceived in them both. In the ſame manner, when two new ideas are preſented to us from the ſtimulus of external bodies, we attend to but one of them at a time. In other words, when one ſet of fibres, whether of the muſcles or organs of ſenſe, contract ſo ſtrongly as to excite much ſenſation; another ſet of fibres contracting more weakly do not excite ſenſation at all, becauſe the ſenſorial power of ſenſation is pre-occupied by the firſt ſet of fibres. So we cannot will more than one effect at once, though by aſſociations previouſly formed we can move many fibres in combination.

Thus in the inſtances above related, the termination of the bile duct in the duodenum, and the exterior extremity of the urethra, are more ſenſible than their other terminations. When theſe parts are deprived of their uſual motions by deficiency of ſenſorial power, as above explained, they become painful according to law the fifth in Section IV. and the leſs pain, originally excited by the ſtimulus of concreted bile, or of a ſtone at their other extremities, ceaſes to be perceived. Afterwards, however, when the concretions of bile, or the ſtone on the urinary bladder, become more numerous or larger, the pain from their increaſed ſtimulus becomes greater than the aſſociated pain; and is then felt at the neck of the gall bladder or urinary bladder; and the pain of the glans penis, or at the pit of the ſtomach, ceaſes to be perceived.

2. Examples of the ſecond mode, where the increaſed action of the primary part of a train of ſenſitive

ſenſitive aſſociation ceaſes, when that of the ſecondary part commences, are alſo not unfrequent; as this is the uſual manner of the tranſlation of inflammations from internal to external parts of the ſyſtem, ſuch as when an inflammation of the liver or ſtomach is tranſlated to the membranes of the foot, and forms the gout; or to the ſkin of the face, and forms the roſy drop; or when an inflammation of the membranes of the kidneys is tranſlated to the ſkin of the loins, and forms one kind of herpes, called ſhingles; in theſe caſes, by whatever cauſe the original inflammation may have been produced, as the ſecondary part of the train of ſenſitive aſſociation is more ſenſible, it becomes exerted with greater violence than the firſt part of it; and by both its increaſed pain, and the increaſed motion of its fibres, ſo far diminiſhes or exhauſts the ſenſorial power of ſenſation, that the primary part of the train being leſs ſenſible ceaſes both to feel pain, and to act with unnatural energy.

3. Examples of the third mode, where the primary part of a train of ſenſitive aſſociation of motions may experience increaſed ſenſation, and the ſecondary part increaſed action, are likewiſe not unfrequent; as it is in this manner that moſt inflammations commence. Thus, after ſtanding ſome time in ſnow, the feet become affected with the pain of cold, and a common coryza, or inflammation of the membrane of the noſtrils, ſucceeds. It is probable that the internal inflammations, as pleuriſies, or hepatitis, which are produced after the cold paroxyſm of fever, originate in the ſame manner from the ſympathy of thoſe parts with ſome others, which were previouſly pained from quieſcence; as happens to various parts of the ſyſtem during the cold fits of fevers. In theſe caſes it would ſeem, that the ſenſorial power of ſenſation becomes accumulated during the pain of cold, as the torpor of the veſſels

veſſels occaſioned by the defect of heat contributes to the increaſe or accumulation of the ſenſorial power of irritation, and that both theſe become exerted on ſome internal part, which was not rendered torpid by the cold which affected the external parts, nor by its aſſociation with them; or which ſooner recovered its ſenſibility. This requires further conſideration.

4. An example of the fourth mode, or where the primary part of a ſenſitive aſſociation of motions may have increaſed action, and the ſecondary part increaſed ſenſation, may be taken from the pain of the ſhoulder, which attends inflammation of the membranes of the liver, ſee Claſs IV. 2. 2. 9.; in this circumſtance ſo much ſenſorial power ſeems to be expended in the violent actions and ſenſations of the inflamed membranes of the liver, that the membranes aſſociated with them become quieſcent to their uſual ſtimuli, and painful in conſequence.

There may be other modes in which the primary and ſecondary parts of the train of aſſociated ſenſitive motions may reciprocally affect each other, as may be ſeen by looking over Claſs IV. in the catalogue of diſeaſes; all which may probably be reſolved into the plus and minus of ſenſorial power, but we have not yet had ſufficient obſervations made upon them with a view to this doctrine.

III. The aſſociated trains of our ideas may have ſympathies, and their primary and ſecondary parts affect each other in ſome manner ſimilar to thoſe above deſcribed; and may thus occaſion various curious phenomena not yet adverted to, beſides thoſe explained in the Sections on Dreams, Reveries, Vertigo, and Drunkenneſs; and may thus diſturb the deductions of our reaſonings, as well as the ſtreams of our imaginations; preſent us with falſe degrees of fear, attach unfounded value to trivial circumſtances; give occaſion to our early prejudices and antipathies;

antipathies; and thus embarraſs the happineſs of our lives. A copious and curious harveſt might be reaped from this province of ſcience, in which, however, I ſhall not at preſent wield my ſickle.

SECT. XXXVI.

OF THE PERIODS OF DISEASES.

I. *Muſcles excited by volition ſoon ceaſe to contract, or by ſenſation, or by irritation, owing to the exhauſtion of ſenſorial power. Muſcles ſubjected to leſs ſtimulus have their ſenſorial power accumulated. Hence the periods of ſome fevers. Want of irritability after intoxication.* II. 1. *Natural actions catenated with daily habits of life.* 2. *With ſolar periods. Periods of ſleep. Of evacuating the bowels.* 3. *Natural actions catenated with lunar periods. Menſtruation. Venereal orgaſm of animals. Barrenneſs.* III. *Periods of diſeaſed animal actions from ſtated returns of nocturnal cold, from ſolar and lunar influence. Periods of diurnal fever, hectic fever, quotidian, tertian, quartan fever. Periods of gout, pleuriſy, of fevers with arterial debility, and with arterial ſtrength. Periods of rhaphania, of nervous cough, hemicrania, arterial hæmorrhages, hæmorrhoids, hæmoptoe, epilepſy, palſy, apoplexy, madneſs.* IV. *Critical days depend on lunar periods. Lunar periods in the ſmall pox.*

I. IF any of our muſcles be made to contract violently by the power of volition, as thoſe of the fingers,

fingers, when any one hangs by his hands on a ſwing, fatigue ſoon enſues; and the muſcles ceaſe to act, owing to the temporary exhauſtion of the ſpirit of animation; as ſoon as this is again accumulated in the muſcles, they are ready to contract again by the efforts of volition.

Thoſe violent muſcular actions induced by pain become in the ſame manner intermitted and recurrent; as in labour-pains, vomiting, teneſmus, ſtrangury; owing likewiſe to the temporary exhauſtion of the ſpirit of animation, as above mentioned.

When any ſtimulus continues long to act with unnatural violence, ſo as to produce too energetic action of any of our moving organs, thoſe motions ſoon ceaſe, though the ſtimulus continues to act; as in looking long on a bright object, as on an inch-ſquare of red ſilk laid on white paper in the ſunſhine. See Plate I. in Sect. III. 1.

On the contrary, where leſs of the ſtimulus of volition, ſenſation, or irrritation, have been applied to a muſcle than uſual; there appears to be an accumulation of the ſpirit of animation in the moving organ; by which it is liable to act with greater energy from leſs quantity of ſtimulus, than was previouſly neceſſary to excite it into ſo great action; as after having been immerſed in ſnow the cutaneous veſſels of our hands are excited into ſtronger action by the ſtimulus of a leſs degree of heat, than would previouſly have produced that effect.

From hence the periods of ſome fever-fits may take their origin, either ſimply, or by their accidental coincidence with lunar and ſolar periods, or with the diurnal periods of heat and cold, to be treated of below; for during the cold fit at the commencement of a fever, from whatever cauſe that cold fit may be induced, it follows, 1. That the ſpirit of animation muſt become accumulated in the

the parts, which exert during this cold fit leſs than their natural quantity of action. 2. If the cauſe producing the cold fit does not increaſe, or becomes diminiſhed; the parts before benumbed or inactive become now excitable by ſmaller ſtimulus, and are thence thrown into more violent action than is natural; that is, a hot fit ſucceeds the cold one. 3. By the energetic action of the ſyſtem during the hot fit, if it continues long, an exhauſtion of the ſpirit of animation takes place, and another cold fit is liable to ſucceed, from the moving ſyſtem not being excitable into action from its uſual ſtimulus. This inirritability of the ſyſtem from a too great previous ſtimulus, and conſequent exhauſtion of ſenſorial power, is the cauſe of the general debility, and ſickneſs, and head-ach, ſome hours after intoxication. And hence we ſee one of the cauſes of the periods of fever-fits; which however are frequently combined with the periods of our diurnal habits, or of heat and cold, or of ſolar or lunar periods.

When beſides the tendency to quieſcence occaſioned by the expenditure of ſenſorial power during the hot fit of fever, ſome other cauſe of torpor, as the ſolar or lunar periods, is neceſſary to the introduction of a ſecond cold fit; the fever becomes of the intermittent kind; that is, there is a ſpace of time intervenes between the end of the hot fit, and the commencement of the next cold one. But where no exteriour cauſe is neceſſary to the introduction of the ſecond cold fit; no ſuch interval of health intervenes; but the ſecond cold fit commences, as ſoon as the ſenſorial power is ſufficiently exhauſted by the hot fit; and the fever becomes continual.

II. 1. The following are natural animal actions, which are frequently catenated with our daily habits of life, as well as excited by their natural irritations. The periods of hunger and thirſt become catenated

catenated with certain portions of time, or degrees of exhauſtion, or other diurnal habits of life. And if the pain of hunger be not relieved by taking food at the uſual time, it is liable to ceaſe till the next period of time or other habits recur; this is not only true in reſpect to our general deſire of food, but the kinds of it alſo are governed by this periodical habit; inſomuch that beer taken to breakfaſt will diſturb the digeſtion of thoſe, who have been accuſtomed to tea; and tea taken at dinner will diſagree with thoſe, who have been accuſtomed to beer. Whence it happens, that thoſe, who have weak ſtomachs, will be able to digeſt more food, if they take their meals at regular hours; becauſe they have both the ſtimulus of the aliment they take, and the periodical habit, to aſſiſt their digeſtion.

The periods of emptying the bladder are not only dependent on the acrimony or diſtention of the water in it, but are frequently catenated with external cold applied to the ſkin, as in cold bathing, or waſhing the hands; or with other habits of life, as many are accuſtomed to empty the bladder before going to bed, or into the houſe after a journey, and this whether it be full or not.

Our times of reſpiration are not only governed by the ſtimulus of the blood in the lungs, or our deſire of freſh air, but alſo by our attention to the hourly objects before us. Hence when a perſon is earneſtly contemplating an idea of grief, he forgets to breathe, till the ſenſation in his lungs becomes very urgent; and then a ſigh ſucceeds for the purpoſe of more forcibly puſhing forwards the blood, which is accumulated in the lungs.

Our times of reſpiration are alſo frequently governed in part by our want of a ſteady ſupport for the actions of our arms, and hands, as in threading a needle, or hewing wood, or in ſwimming; when we are intent upon theſe objects, we breathe at the

the intervals of the exertion of the pectoral muſcles.

2. The following natural animal actions are influenced by ſolar periods. The periods of ſleep and of waking depend much on the ſolar period, for we are inclined to ſleep at a certain hour, and to awake at a certain hour, whether we have had more or leſs fatigue during the day, if within certain limits; and are liable to wake at a certain hour, whether we went to bed earlier or later, within certain limits. Hence it appears, that thoſe who complain of want of ſleep, will be liable to ſleep better or longer, if they accuſtom themſelves to go to reſt, and to riſe, at certain hours.

The periods of evacuating the bowels are generally connected with ſome part of the ſolar day, as well as with the acrimony or diſtenſion occaſioned by the feces. Hence one method of correcting coſtiveneſs is by endeavouring to eſtabliſh a habit of evacuation at a certain hour of the day, as recommended by Mr. Locke, which may be accompliſhed by uſing daily voluntary efforts at thoſe times, joined with the uſual ſtimulus of the material to be evacuated.

3. The following natural animal actions are connected with lunar periods. 1. The periods of female menſtruation are connected with lunar periods to great exactneſs, in ſome inſtances even to a few hours. Theſe do not commence or terminate at the full or change, or at any other particular part of the lunation, but after they have commenced at any part of it, they continue to recur at that part with great regularity, unleſs diſturbed by ſome violent circumſtance, as explained in Sect. XXXII. No. 6. their return is immediately cauſed by deficient venous abſorption, which is owing to the want of the ſtimulus, deſigned by nature, of amatorial copulation, or of the growing fetus. When the catamenia returns

returns ſooner than the period of lunation, it ſhews a tendency of the conſtitution to inirritability; that is, to debility, or deficiency of ſenſorial power, and is to be relieved by ſmall doſes of ſteel and opium.

The venereal orgaſm of birds and quadrupeds ſeems to commence, or return about the moſt powerful lunations at the vernal or autumnal equinoxes; but if it be diſappointed of its object, it is ſaid to recur at monthly periods; in this reſpect reſembling the female catamenia. Whence it is believed, that women are more liable to become pregnant at or about the time of their catamenia, than at the intermediate times; and on this account they are ſeldom much miſtaken in their reckoning of nine lunar periods from the laſt menſtruation; the inattention to this may ſometimes have been the cauſe of ſuppoſed barrenneſs, and is therefore worth the obſervation of thoſe, who wiſh to have children.

III. We now come to the periods of diſeaſed animal actions. The periods of fever-fits, which depend on the ſtated returns of nocturnal cold, are diſcuſſed in Sect. XXXII. 3. Thoſe, which originate or recur at ſolar or lunar periods, are alſo explained in Section XXXII. 6. Theſe we ſhall here enumerate; obſerving, however, that it is not more ſurpriſing, that the influence of the varying attractions of the ſun and moon, ſhould raiſe the ocean into mountains, than that it ſhould affect the nice ſenſibilities of animal bodies; though the manner of its operation on them is difficult to be underſtood. It is probable however, that as this influence gradually leſſens during the courſe of the day, or of the lunation, or of the year, ſome actions of our ſyſtem become leſs and leſs; till at length a total quieſcence of ſome part is induced; which is the commencement of the paroxyſms of fever, of menſtruation, of pain with decreaſed action of the affected organ, and of conſequent convulſion.

1. A diurnal fever in ſome weak people is diſtinctly obſerved to come on towards evening, and to ceaſe with a moiſt ſkin early in the morning, obeying the ſolar periods. Perſons of weak conſtitutions are liable to get into better ſpirits at the acceſs of the hot fit of this evening fever; and are thence inclined to ſit up late; which by further enfeebling them increaſes the diſeaſe; whence they loſe their ſtrength and their colour.

2. The periods of hectic fever, ſuppoſed to ariſe from abſorption of matter, obeys the diurnal periods like the above, having the exacerbeſcence towards evening, and its remiſſion early in the morning, with ſweats, or diarrhœa, or urine with white ſediment.

3. The periods of quotidian fever are either catenated with ſolar time, and return at the intervals of twenty-four hours; or with lunar time, recurring at the intervals of about twenty-five hours. There is great uſe in knowing with what circumſtances the periodical return or new morbid motions are conjoined, as the moſt effectual times of exhibiting the proper medicines are thus determined. So if the torpor, which uſhers in an ague fit, is catenated with the lunar day: it is known, when the bark or opium muſt be given, ſo as to exert its principal effect about the time of the expected return. Solid opium ſhould be given about an hour before the expected cold fit; liquid opium and wine about half an hour; the bark repeatedly for ſix or eight hours previous to the expected return.

4. The periods of tertian fevers, reckoned from the commencement of one cold fit to the commencement of the next cold fit, recur with ſolar intervals of forty-eight hours, or with lunar ones of about fifty hours. When theſe of recurrence begin one or two hours earlier than the ſolar period, it ſhews, that the torpor or cold fit is produced by leſs external influence; and therefore that it is more liable

to

to degenerate into a fever with only remiſſions; ſo when menſtruation recurs ſooner than the period of lunation, it ſhews a tendency of the habit to torpor or inirritability.

5. The periods of quartan fevers return at ſolar intervals of ſeventy-two hours, or at lunar ones of about ſeventy-four hours and an half. This kind of ague appears moſt in moiſt cold autumns, and in cold countries replete with marſhes. It is attended with greater debility, and its cold acceſs more difficult to prevent. For where there is previouſly a deficiency of ſenſorial power, the conſtitution is liable to run into greater torpor from any further diminution of it; two ounces of bark and ſome ſteel ſhould be given on the day before the return of the cold paroxyſm, and a pint of wine by degrees a few hours before its return, and thirty drops of laudanum one hour before the expected cold fit.

6. The periods of the gout generally commence about an hour before ſun-riſe, which is uſually the coldeſt part of the twenty-four hours. The greater periods of the gout ſeem alſo to obſerve the ſolar influence, returning about the ſame ſeaſon of the year.

7. The periods of the pleuriſy recur with exacerbation of the pain and fever about ſun-ſet, at which time veneſection is of moſt ſervice. The ſame may be obſerved of the inflammatory rheumatiſm, and other fevers with arterial ſtrength, which ſeem to obey ſolar periods; and thoſe with debility ſeem to obey lunar ones.

8. The periods of fevers with arterial debility ſeem to obey the lunar day, having their acceſs daily nearly an hour later; and have ſometimes two acceſſes in a day, reſembling the lunar effects upon the tides.

9. The periods of rhaphania, or convulſions of the limbs from rheumatic pains, ſeem to be connected

nected with ſolar influence, returning at nearly the ſame hour for weeks together, unleſs diſturbed by the exhibition of powerful doſes of opium.

So the periods of Tuſſis ferina, or violent cough with ſlow pulſe, called nervous cough, recurs by ſolar periods. Five grains of opium given at the time the cough commenced diſturbed the period, from ſeven in the evening to eleven, at which time it regularly returned for ſome days, during which time the opium was gradually omitted. Then 120 drops of laudanum were given an hour before the acceſs of the cough, and it totally ceaſed. The laudanum was continued a fortnight, and then gradually diſcontinued.

10. The periods of hemicrania, and of painful epilepſy, are liable to obey lunar periods, both in their diurnal returns, and in their greater periods of weeks, but are alſo induced by other exciting cauſes.

11. The periods of arterial hæmorrhages ſeem to return at ſolar periods about the ſame hour of the evening or morning. Perhaps the venous hæmorrhages obey the lunar periods, as the catamenia, and hæmorrhoids.

12. The periods of the hæmorrhoids, or piles, in ſome recur monthly, in others only at the greater lunar influence about the equinoxes.

13. The periods of hæmoptoe ſometimes obey ſolar influence, recurring early in the morning for ſeveral days; and ſometimes lunar periods, recurring monthly; and ſometimes depend on our hours of ſleep. See Claſs I. 2. 1. 9.

14. Many of the firſt periods of epileptic fits obey the monthly lunation with ſome degree of accuracy; others recur only at the moſt powerful lunations before the vernal equinox, and after the autumnal one; but when the conſtitution has gained a habit of

of relieving diſagreeable ſenſations by this kind of exertion, the fit recurs from any ſlight cauſe.

15. The attack of the palſy and apoplexy are known to recur with great frequency about the equinoxes.

16. There are numerous inſtances of the effect of the lunations upon the periods of inſanity, whence the name of lunatic has been given to thoſe afflicted with this diſeaſe.

IV. The critical days, in which fevers are ſuppoſed to terminate, have employed the attention of medical philoſophers from the days of Hippocrates to the preſent time. In whatever part of a lunation a fever commences, which owes either its whole cauſe to ſolar and lunar influence, or to this in conjunction with other cauſes; it would ſeem, that the effect would be the greateſt at the full and new moon, as the tides riſe higheſt at thoſe times, and would be the leaſt at the quadratures; thus if a fever-fit ſhould commence at the new or full moon, occaſioned by the ſolar and lunar attraction diminiſhing ſome chemical affinity of the particles of blood, and thence decreaſing their ſtimulus on our ſanguiferous ſyſtem, as mentioned in Sect. XXXII. 6. this effect will daily decreaſe for the firſt ſeven days, and will then increaſe till about the fourteenth day, and will again decreaſe till about the twenty-firſt day, and increaſe again till the end of the lunation. If a fever-fit from the above cauſe ſhould commence on the ſeventh day after either lunation, the reverſe of the above circumſtances would happen. Now it is probable, that thoſe fevers, whoſe criſis or terminations are influenced by lunations, may begin at one or other of the above times, namely at the changes or quadratures; though ſufficient obſervations have not been made to aſcertain this circumſtance. Hence I conclude, that the ſmall-pox and meaſles have their critical days, not

governed by the times required for certain chemical changes in the blood, which affect or alter the ſtimulus of the contagious matter, but from the daily increaſing or decreaſing effect of this lunar link of catenation, as explained in Section XVII. 3. 3. And as other fevers terminate moſt frequently about the ſeventh, fourteenth, twenty-firſt, or about the end of four weeks, when no medical aſſiſtance has diſturbed their periods, I conclude, that theſe criſes, or terminations, are governed by periods of the lunations, though we are ſtill ignorant of their manner of operation.

In the diſtinct ſmall-pox the veſtiges of lunation are very apparent, after inoculation a quarter of a lunation precedes the commencement of the fever, another quarter terminates with the complete eruption, another quarter with the complete maturation, and another quarter terminates the complete abſorption of a material now rendered inoffenſive to the conſtitution.

SECT.

SECT. XXXVII.

OF DIGESTION, SECRETION, NUTRITION.

I. *Cryſtals increaſe by the greater attraction of their ſides. Accretion by chemical precipitations, by welding, by preſſure, by agglutination.* II. *Hunger, digeſtion, why it cannot be imitated out of the body. Lacteals abſorb by animal ſelection, or appetency.* III. *The glands and pores abſorb nutritious particles by animal ſelection. Organic particles of Buffon. Nutrition applied at the time of elongation of fibres. Like inflammation.* IV. *It ſeems eaſier to have preſerved animals than to reproduce them. Old age and death from inirritability. Three cauſes of this. Original fibres of the organs of ſenſe and muſcles unchanged.* V. *Art of producing long life.*

I. THE larger cryſtals of ſaline bodies may be conceived to ariſe from the combination of ſmaller cryſtals of the ſame form, owing to the greater attractions of their ſides than of their angles. Thus if four cubes were floating in a fluid, whoſe friction or reſiſtance is nothing, it is certain the ſides of theſe cubes would attract each other ſtronger than their angles; and hence that theſe four ſmaller cubes would ſo arrange themſelves as to produce one larger one.

There are other means of chemical accretion, ſuch as the depoſitions of diſſolved calcareous or ſiliceous particles, as are ſeen in the formation of the ſtalactites of limeſtone in Derbyſhire, or of cal-

cedone in Cornwall. Other means of adhesion are produced by heat and pressure, as in the welding of iron bars; and other means by simple pressure, as in forcing two pieces of caoutchou, or elastic gum, to adhere; and lastly, by the agglutination of a third substance penetrating the pores of the other two, as in the agglutination of wood by means of animal gluten. Though the ultimate particles of animal bodies are held together during life, as well as after death, by their specific attraction of cohesion, like all other matter; yet it does not appear, that their original organization was produced by chemical laws, and their production and increase must therefore only be looked for from the laws of animation.

II. When the pain of hunger requires relief, certain parts of the material world, which surround us, when applied to our palates, excite into action the muscles of deglutition; and the material is swallowed into the stomach. Here the new aliment becomes mixed with certain animal fluids, and undergoes a chemical process, termed digestion; which however chemistry has not yet learnt to imitate out of the bodies of living animals or vegetables. This process seems very similar to the saccharine process in the lobes of farinaceous seeds, as of barley, when it begins to germinate; except that, along with the sugar, oil and mucilage are also produced; which form the chyle of animals, which is very similar to their milk.

The reason, I imagine, why this chyle-making, or saccharine process, has not yet been imitated by chemical operations, is owing to the materials being in such a situation in respect to warmth, moisture, and motion; that they will immediately change into the vinous or acetous fermentation; except the new sugar be absorbed by the numerous lacteal

teal or lymphatic veſſels, as ſoon as it is produced; which is not eaſy to imitate in the laboratory.

Theſe lacteal veſſels have mouths, which are irritated into action by the ſtimulus of the fluid, which ſurrounds them; and by animal ſelection, or appetency, they abſorb ſuch part of the fluid as is agreeable to their palate; thoſe parts, for inſtance, which are already converted into chyle, before they have time to undergo another change by a vinous or acetous fermentation. This animal abſorption of fluid is almoſt viſible to the naked eye in the action of the puncta lacrymalia; which imbibe the tears from the eye, and diſcharge them again into the noſtrils.

III. The arteries conſtitute another reſervoir of a changeful fluid; from which, after its recent oxygenation in the lungs, a further animal ſelection of various fluids is abſorbed by the numerous glands; theſe ſelect their reſpective fluids from the blood, which is perpetually undergoing a chemical change; but the ſelection by theſe glands, like that of the lacteals, which open their mouths into the digeſting aliment in the ſtomach, is from animal appetency, not from chemical affinity; ſecretion cannot therefore be imitated in the laboratory, as it conſiſts in a ſelection of part of a fluid during the chemical change of that fluid.

The mouths of the lacteals, and lymphatics, and the ultimate terminations of the glands, are finer than can eaſily be conceived; yet it is probable, that the pores, or interſtices of the parts, or coats, which conſtitute theſe ultimate veſſels, may ſtill have greater tenuity; and that theſe pores from the above analogy muſt poſſeſs a ſimilar power of irritability, and abſorb by their living energy the particles of fluid adapted to their purpoſes, whether to replace the parts abraded or diſſolved, or to elongate and enlarge themſelves. Not only every kind

kind of gland is thus endued with its peculiar appetency, and ſelects the material agreeable to its taſte from the blood, but every individual pore acquires by animal ſelection the material, which it wants; and thus nutrition ſeems to be performed in a manner ſo ſimilar to ſecretion, that they only differ in the one retaining, and the other parting again with the particles, which they have ſelected from the blood.

This way of accounting for nutrition from ſtimulus, and the conſequent animal ſelection of particles, is much more analogous to other phenomena of the animal microcoſm, than by having recourſe to the microſcopic animalcula, or organic particles of Buffon and Needham; which being already compounded muſt themſelves require nutritive particles to continue their own exiſtence. And muſt be liable to undergo a change by our digeſtive or ſecretory organs; otherwiſe mankind would ſoon reſemble by their theory the animals, which they feed upon. He, who is nouriſhed by beef or veniſon, would in time become horned; and he, who feeds on pork or bacon, would gain a noſe proper for rooting into the earth, as well as for the perception of odours.

The whole animal ſyſtem may be conſidered as conſiſting of the extremities of the nerves, or as having been produced from them; if we except perhaps the medullary part of the brain reſiding in the head and ſpine, and in the trunks of the nerves. Theſe extremities of the nerves are either of thoſe of locomotion, which are termed muſcular fibres; or of thoſe of ſenſation, which conſtitute the immediate organs of ſenſe, and which have alſo their peculiar motions. Now as the fibres, which conſtitute the bones and membranes, poſſeſs originally ſenſation and motion; and are liable again to poſſeſs them, when they become inflamed; it follows,

that

that thoſe were, when firſt formed, appendages to the nerves of ſenſation or locomotion, or were formed from them. And that hence all theſe ſolid parts of the body, as they have originally conſiſted of extremities of nerves, require an appoſition of nutritive particles of a ſimilar kind, contrary to the opinion of Buffon and Needham above recited.

Laſtly, as all theſe filaments have poſſeſſed, or do poſſeſs, the power of contraction, and of conſequent inertion or elongation; it ſeems probable, that the nutritive particles are applied during their times of elongation; when their original conſtituent particles are removed to a greater diſtance from each other. For each muſcular or ſenſual fibre may be conſidered as a row or ſtring of beads; which approach, when in contraction, and recede during its reſt or elongation; and our daily experience ſhews us, that great action emaciates the ſyſtem, and that it is repaired during reſt.

Something like this is ſeen out of the body; for if a hair, or a ſingle untwiſted fibre of flax or ſilk, be ſoaked in water; it becomes longer and thicker by the water, which is abſorbed into its pores. Now if a hair could be ſuppoſed to be thus immerſed in a ſolution of particles ſimilar to thoſe, which compoſe it; one may imagine, that it might be thus increaſed in weight and magnitude; as the particles of oak-bark increaſe the ſubſtance of the hides of beaſts in the proceſs of making leather. I mention theſe not as philoſophic analogies, but as ſimiles to facilitate our ideas, how an accretion of parts may be effected by animal appetences, or ſelections, in a manner ſomewhat ſimilar to mechanical or chemical attractions.

If thoſe new particles of matter, previouſly prepared by digeſtion and ſanguification, only ſupply the places of thoſe, which have been abraded by the actions of the ſyſtem, it is properly termed nutrition.

trition. If they are applied to the extremities of the nervous fibrils, or in ſuch quantity as to increaſe the length or craſſitude of them, the body becomes at the ſame time enlarged, and its growth is increaſed, as well as its deficiencies repaired.

In this laſt caſe ſomething more than a ſimple appoſition or ſelection of particles ſeems to be neceſſary; as many parts of the ſyſtem during its growth are cauſed to recede from thoſe, with which they were before in contact; as the ends of the bones, or cartilages, recede from each other, as their growth advances: this proceſs reſembles inflammation, as appears in ophthalmy, or in the production of new fleſh in ulcers, where old veſſels are enlarged, and new ones produced; and like that is attended with ſenſation. In this ſituation the veſſels become diſtended with blood, and acquire greater ſenſibility, and may thus be compared to the erection of the penis, or of the nipples of the breaſts of women; while new particles become added at the ſame time; as in the proceſs of nutrition above deſcribed.

When only the natural growth of the various parts of the body is produced, a pleaſurable ſenſation attends it, as in youth, and perhaps in thoſe, who are in the progreſs of becoming fat. When an unnatural growth is the conſequence, as in inflammatory diſeaſes, a painful ſenſation attends the enlargement of the ſyſtem.

IV. This appoſition of new parts, as the old ones diſappear, ſelected from the aliment we take, firſt enlarges and ſtrengthens our bodies for twenty years, for another twenty years it keeps us in health and vigour, and adds ſtrength and ſolidity to the ſyſtem; and then gradually ceaſes to nouriſh us properly, and for another twenty years we gradually ſink into decay, and finally ceaſe to act, and to exiſt.

On

On conſidering this ſubject one ſhould have imagined at firſt view, that it might have been eaſier for nature to have ſupported her progeny for ever in health and life, than to have perpetually reproduced them by the wonderful and myſterious proceſs of generation. But it ſeems our bodies by long habit ceaſe to obey the ſtimulus of the aliment, which ſhould ſupport us. After we have acquired our height and ſolidity we make no more new parts, and the ſyſtem obeys the irritations, ſenſations, volitions, and aſſociations, with leſs and leſs energy, till the whole ſinks into inaction.

Three cauſes may conſpire to render our nerves leſs excitable, which have been already mentioned. 1. If a ſtimulus be greater than natural, it produces too great an exertion of the ſtimulated organ, and in conſequence exhauſts the ſpirit of animation; and the moving organ ceaſes to act, even though the ſtimulus be continued. And though reſt will recruit this exhauſtion, yet ſome degree of permanent injury remains, as is evident after expoſing the eyes long to too ſtrong a light. 2. If excitations weaker than natural be applied, ſo as not to excite the organ into action, (as when ſmall doſes of aloe or rhubarb are exhibited,) they may be gradually increaſed, without exciting the organ into action; which will thus acquire a habit of diſobedience to the ſtimulus; thus by increaſing the doſe by degrees, great quantities of opium or wine may be taken without intoxication. See Sect. XII. 3. 1.

3. Another mode, by which life is gradually undermined, is when irritative motions continue to be produced in conſequence of ſtimulus, but are not ſucceeded by ſenſation; hence the ſtimulus of contagious matter is not capable of producing fever a ſecond time, becauſe it is not ſucceeded by ſenſation. See Sect. XII. 3. 6. And hence, owing to the want of the general pleaſurable ſenſation, which ought

ought to attend digeſtion and glandular ſecretion, an irkſomeneſs of life enſues; and, where this is in greater exceſs, the melancholy of old age occurs, with torpor or debility.

From hence I conclude, that it is probable that the fibrillæ, or moving filaments at the extremities of the nerves of ſenſe, and the fibres which conſtitute the muſcles (which are perhaps the only parts of the ſyſtem that are endued with contractile life) are not changed, as we advance in years, like the other parts of the body; but only enlarged or elongated with our growth; and in conſequence they become leſs and leſs excitable into action. Whence, inſtead of gradually changing the old animal, the generation of a totally new one becomes neceſſary with undiminiſhed excitability; which many years will continue to excite new parts, or new ſolidity, and then loſing its excitability in time, periſh like its parent.

V. From this idea the art of preſerving long health and life may be deduced; which muſt conſiſt in uſing no greater ſtimulus, whether of the quantity or kind of our food and drink, or of external circumſtances, ſuch as heat, and exerciſe, and wakefulneſs, than is ſufficient to preſerve us in vigour; and gradually, as we grow old, to increaſe the ſtimulus of our aliment, as the inirritability of our ſyſtem increaſes.

The debilitating effects aſcribed by the poet MARTIAL to the exceſſive uſe of warm bathing in Italy, may with equal propriety be applied to the warm rooms of England; which, with the general exceſſive ſtimulus of ſpirituous or fermented liquors, and in ſome inſtances of immoderate venery, contribute to ſhorten our lives.

Balnea, vina, venus, corrumpunt corpora noſtra,
At faciunt vitam balnea, vina, venus!

Wine, women, warmth, againſt our lives combine;
But what is life without warmth, women, wine!

SECT.

SECT. XXXVIII.

OF THE OXYGENATION OF THE BLOOD IN THE LUNGS, AND IN THE PLACENTA.

I. *Blood abſorbs oxygene from the air, whence phoſphoric acid changes its colour, gives out heat, and ſome phlogiſtic material, and acquires an etherial ſpirit, which is diſſipated in fibrous motion.* II. *The placenta is a pulmonary organ like the gills of fiſh. Oxygenation of the blood from air, from water, by lungs, by gills, by the placenta; neceſſity of this oxygenation to quadrupeds, to fiſh, to the fœtus in utero. Placental veſſels inſerted into the arteries of the mother. Uſe of cotyledons in cows. Why quadrupeds have not ſanguiferous lochia. Oxygenation of the chick in the egg, of ſeeds.* III. *The liquor amnii is not excrementitious. It is nutritious. It is found in the eſophagus and ſtomach, and forms the meconium. Monſtrous births without heads. Queſtion of Dr. Harvey.*

I. FROM the recent diſcoveries of many ingenious philoſophers it appears, that during reſpiration the blood imbibes the vital part of the air, called oxygene, through the membranes of the lungs; and that hence reſpiration may be aptly compared to a ſlow combuſtion. As in combuſtion the oxygene of the atmoſphere unites with ſome phlogiſtic or inflammable body, and forms an acid (as in the production of vitriolic acid from ſulphur, or carbonic acid from charcoal,) giving out at the ſame time a quantity of the matter of heat; ſo in reſpiration

ration the oxygene of the air unites with the phlogiſtic part of the blood, and probably produces phoſphoric or animal acid, changing the colour of the blood from a dark to a bright red; and probably ſome of the matter of heat is at the ſame time given out according to the theory of Dr. Crawford. But as the evolution of heat attends almoſt all chemical combinations, it is probable, that it alſo attends the ſecretions of the various fluids from the blood; and that the conſtant combinations or productions of new fluids by means of the glands conſtitute the more general ſource of animal heat; this ſeems evinced by the univerſal evolution of the matter of heat in the bluſh of ſhame or of anger; in which at the ſame time an increaſed ſecretion of the perſpirable matter occurs; and the partial evolution of it from topical inflammations, as in gout or rheumatiſm, in which there is a ſecretion of new blood-veſſels.

Some medical philoſophers have aſcribed the heat of animal bodies to the friction of the particles of the blood againſt the ſides of the veſſels. But no perceptible heat has ever been produced by the agitation of water, or oil, or quickſilver, or other fluids; except thoſe fluids have undergone at the ſame time ſome chemical change, as in agitating milk or wine, till they become ſour.

Beſides the ſuppoſed production of phoſphoric acid, and change of colour of the blood, and the production of carbonic acid, there would appear to be ſomething of a more ſubtile nature perpetually acquired from the atmoſphere; which is too fine to be long contained in animal veſſels, and therefore requires perpetual renovation; and without which life cannot continue longer than a minute or two; this ethereal fluid is probably ſecreted from the blood by the brain, and perpetually diſſipated in the actions of the muſcles and organs of ſenſe.

That

That the blood requires ſomething from the air, which is immediately neceſſary to life, appears from an experiment of Dr. Hare (Philoſ. Tranſact. abridged, Vol. III. p. 239.) who found, "that birds, mice, &c. would live as long again in a veſſel, where he had crowded in double the quantity of air by a condenſing engine, than they did when confined in air of the common denſity." Whereas if ſome kind of deleterious vapour only was exhaled from the blood in reſpiration; the air, when condenſed into half its compaſs, could not be ſuppoſed to receive ſo much of it.

II. Sir Edward Hulſe, a phyſician of reputation at the beginning of the preſent century, was of opinion, that the placenta was a reſpiratory organ, like the gills of fiſh, and not an organ to ſupply nutriment to the fœtus; as mentioned in Derham's Phyſico-theology. Many other phyſicians ſeem to have eſpouſed the ſame opinion, as noticed by Haller. Elem. Phyſiologiæ, T. 1. Dr. Gipſon publiſhed a defence of this theory in the Medical Eſſays of Edinburgh, Vol. I. and II. which doctrine is there controverted at large by the late Alexander Monro, and ſince that time the general opinion has been, that the placenta is an organ of nutrition only, owing perhaps rather to the authority of ſo great a name, than to the validity of the arguments adduced in its ſupport. The ſubject has lately been reſumed by Dr. James Jeffray, and by Dr. Foreſter French, in their inaugural diſſertations at Edinburgh and at Cambridge; who have defended the contrary opinion in an able and ingenious manner; and from whoſe Theſes I have extracted many of the following remarks.

Firſt, by the late diſcoveries of Dr. Prieſtley, M. Lavoiſier, and other philoſophers, it appears, that the baſis of atmoſpherical air, called oxygene, is received by the blood through the membranes of the

the lungs; and that by this addition the colour of the blood is changed from a dark to a light red. Secondly, that water poſſeſſes oxygene alſo as a part of its compoſition, and contains air likewiſe in its pores; whence the blood of fiſh receives oxygene from the water, or from the air it contains, by means of their gills, in the ſame manner as the blood is oxygenated in the lungs of air-breathing animals; it changes its colour at the ſame time from a dark to a light red in the veſſels of their gills, which conſtitute a pulmonary organ adapted to the medium in which they live. Thirdly, that the placenta conſiſts of arteries carrying the blood to its extremities, and a vein bringing it back, reſembling exactly in ſtructure the lungs and gills above mentioned; and that the blood changes its colour from a dark to a light red in paſſing through theſe veſſels.

This analogy between the lungs and gills of animals, and the placenta of the fetus, extends through a great variety of other circumſtances; thus air-breathing creatures and fiſh can live but a few minutes without air or water; or when they are confined in ſuch air or water, as has been ſpoiled by their own reſpiration; the ſame happens to the fetus, which, as ſoon as the placenta is ſeparated from the uterus, muſt either expand its lungs, and receive air, or die. Hence from the ſtructure, as well as the uſe of the placenta, it appears to be a reſpiratory organ, like the gills of fiſh, by which the blood in the fetus becomes oxygenated.

From the terminations of the placental veſſels not being obſerved to bleed after being torn from the uterus, while thoſe of the uterus effuſe a great quantity of florid arterial blood, the terminations of the placental veſſels would ſeem to be inſerted into the arterial ones of the mother; and to receive oxygenation

nation from the paſſing currents of her blood through their coats or membranes; which oxygenation is proved by the change of the colour of the blood from dark to light red in its paſſage from the placental arteries to the placental vein.

The curious ſtructure of the cavities or lacunæ of the placenta, demonſtrated by Mr. J. Hunter, explain this circumſtance. That ingenious philoſopher has ſhewn, that there are numerous cavities or lacunæ formed on that ſide of the placenta, which is in contact with the uterus; thoſe cavities or cells are filled with blood from the maternal arteries, which open into them; which blood is again taken up by the maternal veins, and is thus perpetually changed. While the terminations of the placental arteries and veins are ſpread in fine reticulation on the ſides of theſe cells. And thus, as the growing fetus requires greater oxygenation, an apparatus is produced reſembling exactly the air-cells of the lungs.

In cows, and other ruminating animals, the internal ſurface of the uterus is unequal like hollow cups, which have been called cotyledons; and into theſe cavities the prominencies of the numerous placentas, with which the fetus of thoſe animals is furniſhed, are inſerted, and ſtrictly adhere; though they may be extracted without effuſion of blood. Theſe inequalities of the uterus, and the numerous placentas in conſequence, ſeem to be deſigned for the purpoſe of expanding a greater ſurface for the terminations of the placental veſſels for the purpoſe of receiving oxygenation from the uterine ones; as the progeny of this claſs of animals are more completely formed before their nativity, than that of the carnivorous claſſes, and muſt thence in the latter weeks of pregnancy require greater oxygenation. Thus calves and lambs can walk about in a few minutes

minutes after their birth; while puppies and kittens remain many days without opening their eyes. And though on the ſeparation of the cotyledons of ruminating animals no blood is effuſed, yet this is owing clearly to the greater power of contraction of their uterine lacunæ or alveoli. See Medical Eſſays, Vol. V. page 144. And from the ſame cauſe they are not liable to a ſanguiferous menſtruation.

The neceſſity of the oxygenation of the blood in the fetus is farther illuſtrated by the analogy of the chick in the egg; which appears to have its blood oxygenated at the extremities of the veſſels ſurrounding the yolk; which are ſpread on the air-bag at the broad end of the egg, and may abſorb oxygene through that moiſt membrane from the air confined behind it; and which is ſhewn by experiments in the exhauſted receiver to be changeable though the ſhell.

This analogy may even be extended to the growing ſeeds of vegetables; which were ſhewn by Mr. Scheele to require a renovation of the air over the water, in which they were confined. Many vegetable ſeeds are ſurrounded with air in their pods or receptacles, as peas, the fruit of ſtaphylea, and lichnis veſicaria; but it is probable, that thoſe ſeeds, after they are ſhed, as well as the ſpawn of fiſh, by the ſituation of the former on or near the moiſt and aerated ſurface of the earth, and of the latter in the ever-changing and ventilated water, may not be in need of an apparatus for the oxygenation of their firſt blood, before the leaves of one, and the gills of the other, are produced for this purpoſe.

III. 1. There are many arguments, beſides the ſtrict analogy between the liquor amnii and the albumen ovi, which ſhew the former to be a nutritive fluid; and that the fetus in the latter months of pregnancy takes it into its ſtomach; and that

in

in conſequence the placenta is produced for ſome other important purpoſe.

Firſt, that the liquor amnii is not an excrementitious fluid is evinced, becauſe it is found in greater quantity, when the fetus is young, decreaſing after a certain period till birth. Haller aſſerts, "that in ſome animals but a ſmall quantity of this fluid remains at the birth. In the eggs of hens it is conſumed on the eighteenth day, ſo that at the excluſion of the chick ſcarcely any remains. In rabbits before birth there is none." Elem. Phyſiol. Had this been an excrementitious fluid, the contrary would probably have occurred. Secondly, the ſkin of the fetus is covered with a whitiſh cruſt or pellicle, which would ſeem to preclude any idea of the liquor amnii being produced by any exſudation of perſpirable matter. And it cannot conſiſt of urine, becauſe in brute animals the urachus paſſes from the bladder to the alantois for the expreſs purpoſe of carrying off that fluid; which however in the human fetus ſeems to be retained in the diſtended bladder, as the feces are accumulated in the bowels of all animals.

2. The nutritious quality of the liquid, which ſurrounds the fetus, appears from the following conſiderations. 1. It is coagulable by heat, by nitrous acid, and by ſpirit of wine, like milk, ſerum of blood, and other fluids, which daily experience evinces to be nutritious. 2. It has a ſaltiſh taſte according to the accurate Baron Haller, not unlike the whey of milk, which it even reſembles in ſmell. 3. The white of the egg which conſtitutes the food of the chick, is ſhewn to be nutritious by our daily experience; beſides the experiment of its nutritious effects mentioned by Dr. Fordyce in his late Treatiſe on Digeſtion, p. 178; who adds, that it much reſembles the eſſential parts of the ſerum of blood.

3. A fluid ſimilar to the fluid, with which the fetus is ſurrounded, except what little change may be produced by a beginning digeſtion, is found in the ſtomach of the fetus; and the white of the egg is found in the ſame manner in the ſtomach of the chick.

Numerous hairs, ſimilar to thoſe of its ſkin, are perpetually found among the contents of the ſtomach in new-born calves; which muſt therefore have licked themſelves before their nativity. Blaſii Anatom. See Sect. XVI. 2. on Inſtinct.

The chick in the egg is ſeen gently to move in its ſurrounding fluid, and to open and ſhut its mouth alternately. The ſame has been obſerved in puppies. Haller's El. Phyſ. I. 8. p. 201.

A column of ice has been ſeen to reach down the œſophagus from the mouth to the ſtomach in a frozen fetus; and this ice was the liquor amnii frozen.

The meconium, or firſt fæces, in the bowels of new-born infants evince, that ſomething has been digeſted; and what could this be but the liquor amnii together with the recrements of the gaſtric juice and gall, which were neceſſary for its digeſtion?

There have been recorded ſome monſtrous births of animals without heads, and conſequently without mouths, which ſeem to have been delivered on doubtful authority, or from inaccurate obſervation. There are two of ſuch monſtrous productions however better atteſted; one of a human fetus, mentioned by Gipſon in the Scots Medical Eſſays; which having the gula impervious was furniſhed with an aperture into the wind-pipe, which communicated below into the gullet; by means of which the liquor amnii might be taken into the ſtomach before nativity without danger of ſuffocation, while the fetus had no occaſion to breathe. The other monſtrous fetus is deſcribed by Vander Wiel, who aſſerts, that he

he ſaw a monſtrous lamb, which had no mouth, but inſtead of it was furniſhed with an opening in the lower part of the neck into the ſtomach. Both theſe inſtances evidently favour the doctrine of the fetus being nouriſhed by the mouth; as otherwiſe there had been no neceſſity for new or unnatural apertures into the ſtomach, when the natural ones were deficient.

From theſe facts and obſervations we may ſafely infer, that the fetus in the womb is nouriſhed by the fluid which ſurrounds it; which during the firſt period of geſtation is abſorbed by the naked lacteals; and is afterwards ſwallowed into the ſtomach and bowels, when theſe organs are perfected; and laſtly that the placenta is an organ for the purpoſe of giving due oxygenation to the blood of the fetus; which is more neceſſary, or at leaſt more frequently neceſſary, than even the ſupply of food.

The queſtion of the great Harvey becomes thus eaſily anſwered. "Why is not the fetus in the womb ſuffocated for want of air, when it remains there even to the tenth month without reſpiration; yet if it be born in the ſeventh or eighth month, and has once reſpired, it becomes immediately ſuffocated for want of air, if its reſpiration be obſtructed?"

For further information on this ſubject, the reader is referred to the Tentamen Medicum of Dr. Jeffray, printed at Edinburgh in 1786. And it is hoped that Dr. French will ſome time give his theſes on this ſubject to the public.

SECT. XXXIX.

OF GENERATION.

Felix, qui cauſas altâ caligine meſſas
Pandit, et evolvit tenuiſſima vincula rerum. Anon.

I. *Habits of acting and feeling of individuals attend the ſoul into a future life, and attend the new embryon at the time of its production. The new ſpeck of entity abſorbs nutriment, and receives oxygene. Spreads the terminations of its veſſels on cells, which communicate with the arteries of the uterus; ſometimes with thoſe of the peritoneum. Afterwards it ſwallows the liquor amnii, which it produces by its irritation from the uterus, or peritoneum. Like inſects in the heads of calves and ſheep. Why the white of egg is of two conſiſtencies. Why nothing is found in quadrupeds ſimilar to the yolk, nor in moſt vegetable ſeeds.* II. 1. *Eggs of frogs and fiſh impregnated out of their bodies. Eggs of fowls which are not fecundated, contain only the nutriment for the embryon. The embryon is produced by the male, and the nutriment by the female. Animalcula in ſemine. Profuſion of nature's births.* 2. *Vegetables viviparous. Buds and bulbs have each a father, but no mother. Veſſels of the leaf and bud inoſculate. The paternal offspring exactly reſembles the parent.* 3. *Inſects impregnated for ſix generations. Polypus branches like buds. Creeping roots. Viviparous flowers. Tænia, volvox. Eve from Adam's rib. Semen not a ſtimulus to the egg.* III. 1. *Embryons not originally created within other embryons. Organized matter is not ſo minute.* 2. *All the parts of the embryon are not formed in the male parent. Crabs produce their legs, worms produce their heads and tails. In wens, cancers, and inflammations, new veſſels are formed. Mules partake of the forms of both parents. Hair and nails grow by elongation, not by diſtention.* 3. *Organic particles of Buffon.* IV. 1. *Rudiment of the embryon a ſimple living filament, becomes a living ring, and then a living tube.* 2. *It*

It acquires new irritabilities, and ſenſibilities with new organizations, as in wounded ſnails, polypi, moths, gnats, tadpoles. Hence new parts are acquired by addition not by diſtention. 3. *All parts of the body grow if not confined.* 4. *Fetuſes deficient at their extremities, or have a duplicature of parts. Monſtrous births. Double parts of vegetables.* 5. *Mules cannot be formed by diſtention of the ſeminal ens.* 6. *Families of animals from a mixture of their orders. Mules imperfect.* 7. *Animal appetency like chemical affinity. Vis fabricatrix and medicatrix of nature.* 8. *The changes of animals before and after nativity. Similarity of their ſtructure. Changes in them from luſt, hunger and danger. All warm-blooded animals derived from one living filament. Cold-blooded animals, inſects, worms, vegetables, derived alſo from one living filament. Male animals have teats. Male pigeon gives milk. The world itſelf generated. The cauſe of cauſes. A ſtate of probation and reſponſibility.* V. 1. *Efficient cauſe of the colours of birds eggs, and of hair and feathers, which become white in ſnowy countries. Imagination of the female colours the egg Ideas or motions of the retina imitated by the extremities of the nerves of touch, or rete mucoſum.* 2. *Nutriment ſupplied by the female of three kinds. Her imagination can only affect the firſt kind. Mules how produced, and mulattoes. Organs of reproduction why deficient in mules. Eggs with double yolks.* VI. 1. *Various ſecretions produced by the extremities of the veſſels, as in the glands. Contagious matter. Many glands affected by pleaſurable ideas, as thoſe which ſecrete the ſemen* 2. *Snails and worms are hermaphrodite, yet cannot impregnate themſelves. Final cauſe of this.* 3. *The imagination of the male forms the ſex. Ideas, or motions of the nerves of viſion or of touch, are imitated by the ultimate extremities of the glands of the teſtes, which mark the ſex. This effect of the imagination belongs only to the male. The ſex of the embryon is not owing to accident.* 4. *Cauſes of the changes in animals from imagination as in monſters. From the male. From the female.* 5. *Miſcarriages from fear.* 6. *Power of the imagination of the male over the colour, form, and ſex of the progeny. An inſtance of.* 7. *Act of generation accompanied with ideas of the male or female form. Art of begetting beautiful children of either ſex.* VII. *Recapitulation.* VIII. *Concluſion. Of cauſe and effect. The atomic philoſophy leads to a firſt cauſe.*

I. THE ingenious Dr. Hartley in his work on man, and ſome other philoſophers, have been of opinion

opinion, that our immortal part acquires during this life certain habits of action or of ſentiment, which become for ever indiſſoluble, continuing after death in a future ſtate of exiſtence; and add, that if theſe habits are of the malevolent kind, they muſt render the poſſeſſor miſerable even in heaven. I would apply this ingenious idea to the generation or production of the embryon, or new animal, which partakes ſo much of the form and propenſities of the parent.

Owing to the imperfection of language the offſpring is termed a *new* animal, but is in truth a branch or elongation of the parent; ſince a part of the embryon-animal is, or was, a part of the parent; and therefore in ſtrict language it cannot be ſaid to be entirely *new* at the time of its production; and therefore it may retain ſome of the habits of the parent-ſyſtem.

At the earlieſt period of its exiſtence the embryon, as ſecreted from the blood of the male, would ſeem to conſiſt of a living filament with certain capabilities of irritation, ſenſation, volition, and aſſociation; and alſo with ſome acquired habits or propenſities peculiar to the parent: the former of theſe are in common with other animals; the latter ſeem to diſtinguiſh or produce the kind of animal, whether man or quadruped, with the ſimilarity of feature or form to the parent. It is difficult to be conceived, that a living entity can be ſeparated or produced from the blood by the action of a gland; and which ſhall afterwards become an animal ſimilar to that in whoſe veſſels it is formed; even though we ſhould ſuppoſe with ſome modern theoriſts, that the blood is alive; yet every other hypotheſis concerning generation reſts on principles ſtill more difficult to our comprehenſion.

At the time of procreation this ſpeck of entity is received into an appropriated nidus, in which it muſt

muſt acquire two circumſtances neceſſary to its life and growth; one of theſe is food or ſuſtenance, which is to be received by the abſorbent mouths of its veſſels; and the other is that part of atmoſpherical air, or of water, which by the new chemiſtry is termed oxygene, and which affects the blood by paſſing through the coats of the veſſels which contain it. The fluid ſurrounding the embryon in its new habitation, which is called liquor amnii, ſupplies it with nouriſhment; and as ſome air cannot but be introduced into the uterus along with a new embryon, it would ſeem that this ſame fluid would for a ſhort time, ſuppoſe for a few hours, ſupply likewiſe a ſufficient quantity of the oxygene for its immediate exiſtence.

On this account the vegetable impregnation of aquatic plants is performed in the air; and it is probable that the honey-cup or nectary of vegetables requires to be open to the air, that the anthers and ſtigmas of the flower may have food of a more oxygenated kind than the common vegetable ſap-juice.

On the introduction of this primordium of entity into the uterus, the irritation of the liquor amnii, which ſurrounds it, excites the abſorbent mouths of the new veſſels into action; they drink up a part of it, and a pleaſurable ſenſation accompanies this new action; at the ſame time the chemical affinity of the oxygene acts through the veſſels of the rubeſcent blood; and a previous want, or diſagreeable ſenſation, is relieved by this proceſs.

As the want of this oxygenation of the blood is perpetual, (as appears from the inceſſant neceſſity of breathing by lungs or gills,) the veſſels become extended by the efforts of pain or deſire to ſeek this neceſſary object of oxygenation, and to remove the diſagreeable ſenſation, which that want occaſions. At the ſame time new particles of matter are abſorbed

abſorbed, or applied to theſe extended veſſels, and they become permanently elongated, as the fluid in contact with them ſoon loſes the oxygenous part, which it at firſt poſſeſſed, which was owing to the introduction of air along with the embryon. Theſe new blood-veſſels approach the ſides of the uterus, and penetrate with their fine terminations into the veſſels of the mother; or adhere to them, acquiring oxygene through their coats from the paſſing currents of the arterial blood of the mother. See Sect. XXXVIII. 2.

This attachment of the placental veſſels to the internal ſide of the uterus by their own proper efforts appears further illuſtrated by the many inſtances of extra-uterine fetuſes, which have thus attached or inſerted their veſſels into the peritoneum; or on the viſcera, exactly in the ſame manner as they naturally inſert or attach them to the uterus.

The abſorbent veſſels of the embryon continue to drink up nouriſhment from the fluid in which they ſwim, or liquor amnii; and which at firſt needs no previous digeſtive preparation; but which, when the whole apparatus of digeſtion becomes complete, is ſwallowed by the mouth into the ſtomach, and being mixed with ſaliva, gaſtric juice, bile, pancreatic juice, and mucus of the inteſtines, becomes digeſted, and leaves a recrement, which produces the firſt feces of the infant, called meconium.

The liquor amnii is ſecreted into the uterus, as the fetus requires it, and may probably be produced by the irritation of the fetus as an extraneous body; ſince a ſimilar fluid is acquired from the peritoneum in caſes of extra-uterine geſtation. The young caterpillars of the gadfly placed in the ſkins of cows, and the young of the ichneumon-fly placed in the backs of the caterpillars on cabbages, ſeem to produce their nouriſhment by their irritating the ſides of their nidus. A vegetable ſecretion and concretion is thus produced on oak-leaves by the gall-

inſect,

inſect, and by the cynips in the bedeguar of the roſe; and by the young graſshopper on many plants, by which the animal ſurrounds itſelf with froth. But in no circumſtance is extra-uterine geſtation ſo exactly reſembled as by the eggs of a fly, which are depoſited in the frontal ſinus of ſheep and calves. Theſe eggs float in ſome ounces of fluid collected in a thin pellicle or hydatide. This bag of fluid compreſſes the optic nerve on one ſide, by which the viſion being leſs diſtinct in that eye, the animal turns in perpetual circles towards the ſide affected, in order to get a more accurate view of objects; for the ſame reaſon as in ſquinting the affected eye is turned away from the object contemplated. Sheep in the warm months keep their noſes cloſe to the ground to prevent this fly from ſo readily getting into their noſtrils.

The liquor amnii is ſecreted into the womb as it is required, not only in reſpect to quantity, but, as the digeſtive powers of the fetus become formed, this fluid becomes of a different conſiſtence and quality, till it is exchanged for milk after nativity. Haller. Phyſiol. V. 1. In the egg the white part, which is analogous to the liquor amnii of quadrupeds, conſiſts of two diſtinct parts; one of which is more viſcid, and probably more difficult of digeſtion, and more nutritive than the other; and this latter is uſed in the laſt week of incubation. The yolk of an egg is ſtill a ſtronger or more nutritive fluid, which is drawn up into the bowels of the chick juſt at its excluſion from the ſhell, and ſerves it for nouriſhment for a day or two, till it is able to digeſt and has learnt to chooſe the harder ſeeds or grains, which are to afford it ſuſtenance. Nothing analogous to this yolk is found in the fetus of lactiferous animals, as the milk is another nutritive fluid ready prepared for the young progeny.

The yolk therefore is not neceſſary to the ſpawn of fiſh, the eggs of inſects, or for the ſeeds of vegetables;

tables; as their embryons have probably their food preſented to them as ſoon as they are excluded from their ſhells, or have extended their roots. Whence it happens that ſome inſects produce a living progeny in the ſpring and ſummer, and eggs in the autumn; and ſome vegetables have living roots or buds produced in the place of ſeeds, as the polygonum viviparum, and magical onions. See Botanic Garden, p. ii, art. anthoxanthum.

There ſeems however to be a reſervoir of nutriment prepared for ſome ſeeds beſides their cotyledons or ſeed-leaves, which may be ſuppoſed in ſome meaſure analogous to the yolk of the egg. Such are the ſaccharine juices of apples, grapes and other fruits, which ſupply nutrition to the ſeeds after they fall on the ground. And ſuch is the milky juice in the centre of the cocoa-nut, and part of the kernel of it; the ſame I ſuppoſe of all other monocotyledon ſeeds, as of the palms, graſſes, and lilies.

II. 1. The proceſs of generation is ſtill involved in impenetrable obſcurity, conjectures may nevertheleſs be formed concerning ſome of its circumſtances. Firſt, the eggs of fiſh and frogs are impregnated, after they leave the body of the female, becauſe they are depoſited in a fluid, and are not therefore covered with a hard ſhell. It is however remarkable, that neither frogs nor fiſh will part with their ſpawn without the preſence of the male; on which account female carp and gold-fiſh in ſmall ponds, where there are no males, frequently die from the diſtention of their growing ſpawn. 2. The eggs of fowls, which are laid without being impregnated, are ſeen to contain only the yolk and white, which are evidently the food or ſuſtenance for the future chick. 3. As the cicatricula of theſe eggs is given by the cock, and is evidently the rudiment of the new animal, we may conclude, that the embryon is produced by the male, and the proper food

and

and nidus by the female. For if the female be ſuppoſed to form an equal part of the embryon, why ſhould ſhe form the whole of the apparatus for nutriment and for oxygenation? the male in many animals is larger, ſtronger, and digeſts more food than the female, and therefore ſhould contribute as much or more towards the reproduction of the ſpecies; but if he contributes only half the embryon and none of the apparatues for ſuſtenance and oxygenation, the diviſion is unequal; the ſtrength of the male, and his conſumption of food are too great for the effect, compared with that of the female, which is contrary to the uſual courſe of nature.

In objection to this theory of generation it may be ſaid, if the animalcula in ſemine, as ſeen by the microſcope, be all of them rudiments of homunculi, when but one of them can find a nidus, what a waſte nature has made of her productions? I do not aſſert that theſe moving particles, viſible by the microſcope, are homunciones; perhaps they may be the creatures of ſtagnation or putridity, or perhaps no creatures at all; but if they are ſuppoſed to be rudiments of homunculi, or embryons, ſuch a profuſion of them correſponds with the general effort of nature to provide for the continuance of her ſpecies of animals. Every individual tree produces innumerable ſeeds, and every individual fiſh innumerable ſpawn, in ſuch inconceivable abundance as would in a ſhort ſpace of time crowd the earth and ocean with inhabitants, and theſe are much more perfect animals than the animalcula in ſemine can be ſuppoſed to be, and periſh in uncounted millions. This argument only ſhews, that the productions of nature are governed by general laws, and that by a wiſe ſuperfluity of proviſion ſhe has enſured their continuance.

2. That the embryon is ſecreted or produced by the male, and not by the conjunction of fluids from both male and female, appears from the analogy of vegetable

vegetable ſeeds. In the large flowers, as the tulip, there is no ſimilarity of apparatus between the anthers and the ſtigma: the ſeed is produced according to the obſervations of Spallanzani long before the flowers open, and in conſequence long before it can be impregnated, like the egg in the pullet. And after the prolific duſt is ſhed on the ſtigma, the ſeed becomes coagulated in one point firſt, like the catricula of the impregnated egg. See Botanic Garden, Part I. additional note 38. Now in theſe ſimple products of nature, if the female contributed to produce the new embryon equally with the male, there would probably have been ſome viſible ſimilarity of parts for this purpoſe, beſides thoſe neceſſary for the nidus and ſuſtenance of the new progeny. Beſides in many flowers the males are more numerous than the females, or than the ſeparate uterine cells in their germs, which would ſhew, that the office of the male was at leaſt as important as that of the female; whereas if the female, beſides producing the egg or ſeed, was to produce an equal part of the embryon, the office of reproduction would be unequally divided between them.

Add to this, that in the moſt ſimple kind of vegetable reproduction, I mean the buds of trees, which are their viviparous offſpring, the leaf is evidently the parent of the bud, which riſes in its boſom, according to the obſervation of Linnæus. This leaf conſiſts of abſorbent veſſels, and pulmonary ones, to obtain its nutriment, and to impregnate it with oxygene. This ſimple piece of living organization is alſo furniſhed with a power of reproduction; and as the new offſpring is thus ſupported adhering to its father, it needs no mother to ſupply it with a nidus, and nutriment, and oxygenation; and hence no female leaf has exiſtence.

I conceive that the veſſels between the bud and the leaf communicate or inoſculate; and that the bud is thus ſerved with vegetable blood, that is,

with

with both nutriment and oxygenation, till the death of the parent-leaf in autumn. And in this reſpect it differs from the fetus of viviparous animals. Secondly, that then the bark-veſſels belonging to the dead-leaf, and in which I ſuppoſe a kind of manna to have been depoſited, become now the placental veſſels, if they may be ſo called, of the new bud. From the vernal ſap thus produced of one ſugar-maple-tree in New-York and in Pennſylvania, five or ſix pounds of good ſugar may be made annually without deſtroying the tree. Account of maple-ſugar by B. Ruſh. London, Phillips. (See Botanic Garden, Part I. additional note on vegetable placentation.)

Theſe veſſels, when the warmth of the vernal ſun hatches the young bud, ſerve it with a ſaccharine nutriment, till it acquires leaves of its own, and ſhoots a new ſyſtem of abſorbents down the bark and root of the tree, juſt as the farinaceous or oily matter in ſeeds, and the ſaccharine matter in fruits, ſerve their embryons with nutriment, till they acquire leaves and roots. This analogy is as forceable in ſo obſcure a ſubject, as it is curious, and may in large buds, as of the horſe-cheſnut, be almoſt ſeen by the naked eye; if with a pen-knife the remaining rudiment of the laſt year's leaf, and of the new bud in its boſom, be cut away ſlice by ſlice. The ſeven ribs of the laſt year's leaf will be ſeen to have ariſen from the pith in ſeven diſtinct points making a curve; and the new bud to have been produced in their centre, and to have pierced the alburnum and cortex, and grown without the aſſiſtance of a mother. A ſimilar proceſs may be ſeen on diſſecting a tulip-root in winter; the leaves, which incloſed the laſt year's flower-ſtalk, were not neceſſary for the flower; but each of theſe was the father of a new bud, which may be now found at its baſe; and which, as it adheres to the parent, required no mother.

This paternal offspring of vegetables, I mean their buds and bulbs, is attended with a very curious circumſtance;

cumſtance; and that is, that they exactly reſemble their parents, as is obſervable in grafting fruit-trees, and in propagating flower-roots; whereas the ſeminal offspring of plants, being ſupplied with nutriment by the mother, is liable to perpetual variation. Thus alſo in the vegetable claſs dioicia, where the male flowers are produced on one tree, and the female ones on another, the buds of the male trees uniformly produce either male flowers, or other buds ſimilar to themſelves; and the buds of the female trees produce either female flowers, or other buds ſimilar to themſelves; whereas the ſeeds of theſe trees produce either male or female plants. From this analogy of the production of vegetable buds without a mother, I contend that the mother does not contribute to the formation of the living ens in animal generation, but is neceſſary only for ſupplying its nutriment and oxygenation.

There is another vegetable fact publiſhed by M. Koelreuter, which he calls "a complete metamorphoſis of one natural ſpecies of plants into another," which ſhews, that in ſeeds as well as in buds, the embryon proceeds from the male parent, though the form of the ſubſequent mature plant is in part dependant on the female. M. Koelreuter impregnated a ſtigma of the nicotiana ruſtica with the farina of the nicotiana paniculata; and obtained prolific ſeeds from it. With the plants which ſprung from theſe ſeeds, he repeated the experiment, impregnating them with the farina of the nicotiana paniculata. As the mule plants which he thus produced were prolific, he continued to impregnate them for many generations with the farina of the nicotiana paniculata, and they became more and more like the male parent, till he at length obtained ſix plants in every reſpect perfectly ſimilar to the nicotiana paniculata; and in no reſpect reſembling their female

female parent the nicotiana ruſtica. *Blumenbach* on Generation.

3. It is probable that the inſects, which are ſaid to require but one impregnation for ſix generations, as the aphis (ſee Amenit. Academ.) produce their progeny in the manner above deſcribed, that is, without a mother, and not without a father; and thus experience a lucina ſine concubitu. Thoſe who have attended to the habits of the polypus, which is found in the ſtagnant water of our ditches in July, affirm, that the young ones branch out from the ſide of the parent like the buds of trees, and after a time ſeparate themſelves from them. This is ſo analogous to the manner in which the buds of trees appear to be produced, that theſe polypi may be conſidered as all male animals, producing embryons, which require no mother to ſupply them with a nidus, or with nutriment, and oxygenation.

This lateral or lineal generation of plants, not only obtains in the buds of trees, which continue to adhere to them, but is beautifully ſeen in the wires of knot-graſs, polygonum aviculare, and in thoſe of ſtrawberries, fragaria veſca. In theſe an elongated creeping bud is protruded, and, where it touches the ground, takes root, and produces a new plant derived from its father, from which it acquires both nutriment and oxygenation; and in conſequence needs no maternal apparatus for theſe purpoſes. In viviparous flowers, as thoſe of allium magicum, and polygonum viviparum, the anthers and the ſtigmas become effete and periſh; and the lateral or paternal offspring ſucceeds inſtead of ſeeds, which adhere till they are ſufficiently mature, and then fall upon the ground, and take root like other bulbs.

The lateral production of plants by wires, while each new plant is thus chained to its parent, and continues to put forth another and another, as the wire

wire creeps onward on the ground, is exactly reſembled by the tape-worm, or tænia, ſo often found in the bowels, ſtretching itſelf in a chain quite from the ſtomach to the rectum. Linnæus aſſerts, "that it grows old at one extremity, while it continues to generate young ones at the other, proceeding ad infinitum, like a root of graſs. The ſeparate joints are called gourd-worms, and propagate new joints like the parent without end, each joint being furniſhed with its proper mouth, and organs of digeſtion." Syſtema naturæ. Vermes tenia. In this animal there evidently appears a power of reproduction without any maternal apparatus for the purpoſe of ſupplying nutriment and oxygenation to the embryon, as it remains attached to its father till its maturity. The volvox globator, which is a tranſpatent animal, is ſaid by Linnæus to bear within it ſons and grand ſons to the fifth generation. Theſe are probably living fetuſes, produced by the father, of different degrees of maturity, to be detruded at different periods of time, like the unimpregnated eggs of various ſizes, which are found in poultry; and as they are produced without any known copulation, contribute to evince, that the living embryon in other orders of animals is formed by the male-parent, and not by the mother, as one parent has the power to produce it.

This idea of the reproduction of animals from a ſingle living filament of their fathers, appears to have been ſhadowed or allegorized in the curious account in ſacred writ of the formation of Eve from a rib of Adam.

From all theſe analogies I conclude, that the embryon is produced ſolely by the male, and that the female ſupplies it with a proper nidus, with ſuſtenance, and with oxygenation; and that the idea of the ſemen of the male conſtituting only a ſtimulus to the egg of the female, exciting it into life, (as held

held by ſome philoſophers) has no ſupport from experiment or analogy.

III. 1. Many ingenious philoſophers have found ſo great difficulty in conceiving the manner of the reproduction of animals, that they have ſuppoſed all the numerous progeny to have exiſted in miniature in the animal originally created; and that theſe infinitely minute forms are only evolved or diſtended, as the embryon increaſes in the womb. This idea, beſides its being unſupported by any analogy we are acquainted with, aſcribes a greater tenuity to organized matter, than we can readily admit; as theſe included embryons are ſuppoſed each of them to conſiſt of the various and complicate parts of animal bodies; they muſt poſſeſs a much greater degree of minuteneſs, than that which was aſcribed to the devils that tempted St. Anthony; of whom 20,000 were ſaid to have been able to dance a ſaraband on the point of the fineſt needle without incommoding each other.

2. Others have ſuppoſed, that all the parts of the embryon are formed in the male, previous to its being depoſited in the egg or uterus; and that it is then only to have its parts evolved or diſtended as mentioned above; but this is only to get rid of one difficulty by propoſing another equally incomprehenſible: they found it difficult to conceive, how the embryon could be formed in the uterus or egg, and therefore wiſhed it to be formed before it came thither. In anſwer to both theſe doctrines it may be obſerved, 1ſt, that ſome animals, as the crab-fiſh, can reproduce a whole limb, as a leg which has been broken off; others, as worms and ſnails, can reproduce a head or a tail, when either of them has been cut away; and that hence in theſe animals at leaſt a part can be formed anew, which cannot be ſuppoſed to have exiſted previouſly in miniature.

Secondly, there are new parts or new veſſels produced in many diſeaſes, as on the cornea of the eye in ophthalmy, in wens and cancers, which cannot be ſuppoſed to have had a prototype or original miniature in the embryon.

Thirdly, how could mule-animals be produced, which partake of the forms of both the parents, if the original embryon was a miniature exiſting in the ſemen of the male parent? if an embryon of the male aſs was only expanded, no reſemblance to the mare could exiſt in the mule.

This miſtaken idea of the extenſion of parts ſeems to have had its riſe from the mature man reſembling the general form of the fetus; and from thence it was believed, that the parts of the fetus were diſtended into the man; whereas they have increaſed 100 times in weight, as well as 100 times in ſize; now no one will call the additional 99 parts a diſtention of the original one part in reſpect to weight. Thus the uterus during pregnancy is greatly enlarged in thickneſs and ſolidity as well as in capacity, and hence muſt have acquired this additional ſize by accretion of new parts, not by an extenſion of the old ones; the familiar act of blowing up the bladder of an animal recently ſlaughtered has led our imaginations to apply this idea of diſtention to the increaſe of ſize from natural growth; which however muſt be owing to the appoſition of new parts; as it is evinced from the increaſe of weight along with the increaſe of dimenſion; and is even viſible to our eyes in the elongation of our hair from the colour of its ends; or when it has been dyed on the head; and in the growth of our nails from the ſpecks ſometimes obſervable on them; and in the increaſe of the white creſcent at their roots, and in the growth of new fleſh in wounds, which conſiſts of new nerves as well as of new blood-veſſels.

3. Laſtly,

3. Laſtly, Mr. Buffon has with great ingenuity imagined the exiſtence of certain organic particles, which are ſuppoſed to be partly alive, and partly mechanic ſprings. The latter of theſe were diſcovered by Mr. Needham in the milt or male organ of a ſpecies of cuttle fiſh, called calmar; the former, or living animalcula, are found in both male and female ſecretions, in the infuſions of ſeeds, as of pepper, in the jelly of roaſted veal, and in all other animal and vegetable ſubſtances. Theſe organic particles he ſuppoſes to exiſt in the ſpermatic fluids of both ſexes, and that they are derived thither from every part of the body, and muſt therefore reſemble, as he ſuppoſes, the parts from whence they are derived. Theſe organic particles he believes to be in conſtant activity, till they become mixed in the womb, and then they inſtantly join and produce an embryon or fetus ſimilar to the two parents.

Many objections might be adduced to this fanciful theory; I ſhall only mention two. Firſt, that it is analogous to no known animal laws. And ſecondly, that as theſe fluids, replete with organic particles derived both from the male and female organs, are ſuppoſed to be ſimilar; there is no reaſon why the mother ſhould not produce a female embryon without the aſſiſtance of the male, and realize the lucina ſine concubitu.

IV. 1. I conceive the primordium, or rudiment of the embryon, as ſecreted from the blood of the parent, to conſiſt of a ſimple living filament as a muſcular fibre; which I ſuppoſe to be an extremity of a nerve of loco-motion, as a fibre of the retina is an extremity of a nerve of ſenſation; as for inſtance one of the fibrils, which compoſe the mouth of an abſorbent veſſel; I ſuppoſe this living filament, of whatever form it may be, whether ſphere, cube, or cylinder, to be endued with the capability of being

excited into action by certain kinds of ſtimulus. By the ſtimulus of the ſurrounding fluid, in which it is received from the male, it may bend into a ring, and thus form the beginning of a tube. Such moving filaments, and ſuch rings, are deſcribed by thoſe, who have attended to microſcopic animalcula. This living ring may now embrace or abſorb a nutritive particle of the fluid, in which it ſwims; and by drawing it into its pores, or joining it by compreſſion to its extremities, may increaſe its own length or craſſitude; and by degrees the living ring may become a living tube.

2. With this new organization, or accretion of parts, new kinds of irritability may commence; for ſo long as there was but one living organ, it could only be ſuppoſed to poſſeſs irritability; ſince ſenſibility may be conceived to be an extenſion of the effect of irritability over the reſt of the ſyſtem. Theſe new kinds of irritability and of ſenſibility in conſequence of new organization, appear from variety of facts in the more mature animal; thus the formation of the teſtes, and conſequent ſecretion of the ſemen, occaſion the paſſion of luſt; the lungs muſt be previouſly formed before their exertions to obtain freſh air can exiſt; the throat or œſophagus muſt be formed previous to the ſenſation or appetites of hunger and thirſt; one of which ſeems to reſide at the upper end, and the other at the lower end of that canal.

Thus alſo the glans penis, which is diſtended with blood, acquires a new ſenſibility, and a new appetency. The ſame occurs to the nipples of the breaſts of female animals, when they are diſtended with blood, they acquire the new appetency of giving milk. So inflamed tendons and membranes, and even bones, acquire new ſenſations; and the parts of mutilated animals, as of wounded ſnails, and polypi, and crabs, are reproduced; and at the

ſame

ſame time acquire ſenſations adapted to their ſituations. Thus when the head of a ſnail is reproduced after decollation with a ſharp raſor, thoſe curious teleſcopic eyes are alſo reproduced, and acquire their ſenſibility to light, as well as their adapted muſcles for retraction on the approach of injury.

With every new change, therefore, of organic form, or addition of organic parts, I ſuppoſe a new kind of irritability or of ſenſibility to be produced; ſuch varieties of irritability or of ſenſibility exiſt in our adult ſtate in the glands; every one of which is furniſhed with an irritability, or a taſte, or appetency, and a conſequent mode of action peculiar to itſelf.

In this manner I conceive the veſſels of the jaws to produce thoſe of the teeth, thoſe of the fingers to produce the nails, thoſe of the ſkin to produce the hair; in the ſame manner as afterwards about the age of puberty the beard and other great changes in the form of the body, and diſpoſition of the mind, are produced in conſequence of the new ſecretion of ſemen; for if the animal is deprived of this ſecretion thoſe changes do not take place. Theſe changes I conceive to be formed not by elongation or diſtention of primeval ſtamina, but by appoſition of parts; as the mature crab-fiſh, when deprived of a limb, in a certain ſpace of time has power to regenerate it; and the tadpole puts forth its feet long after its excluſion from the ſpawn; and the caterpillar in changing into a butterfly acquires a new form, with new powers, new ſenſations, and new deſires.

The natural hiſtory of butterflies, and moths, and beetles, and gnats, is full of curioſity; ſome of them paſs many months, and others even years, in their caterpillar or grub ſtate; they then reſt many weeks without food, ſuſpended in the air, buried in the earth, or ſubmerſed in water; and change themſelves

themſelves during this time into an animal apparently of a different nature; the ſtomachs of ſome of them, which before digeſted vegetable leaves or roots, now only digeſt honey; they have acquired wings for the purpoſe of ſeeking this new food, and a long proboſcis to collect it from flowers, and I ſuppoſe a ſenſe of ſmell to detect the ſecret places in flowers, where it is formed. The moths, which fly by night, have a much longer proboſcis rolled up under their chins like a watch ſpring; which they extend to collect the honey from flowers in their ſleeping ſtate; when they are cloſed, and the nectaries in conſequence more difficult to be plundered. The beetle kind are furniſhed with an external covering of a hard material to their wings, that they may occaſionally again make holes in the earth, in which they paſſed the former ſtate of their exiſtence.

But what moſt of all diſtinguiſhes theſe new animals is, that they are new furniſhed with the powers of reproduction; and that they now differ from each other in ſex, which does not appear in their caterpillar or grub ſtate. In ſome of them the change from a caterpillar into a butterfly or moth ſeems to be accompliſhed for the ſole purpoſe of their propagation; ſince they immediately die after this is finiſhed, and take no food in the interim, as the ſilk-worm in this climate; though it is poſſible, it might take honey as food, if it was preſented to it. For in general it would ſeem, that food of a more ſtimulating kind, the honey of vegetables inſtead of their leaves, was neceſſary for the purpoſe of the ſeminal reproduction of theſe animals, exactly ſimilar to what happens in vegetables; in theſe the juices of the earth are ſufficient for their purpoſe of reproduction by buds or bulbs; in which the new plant ſeems to be formed by irritative motions, like the growth of their other parts, as their

leaves

leaves or roots; but for the purpoſe of ſeminal or amatorial reproduction, where ſenſation is required, a more ſtimulating food becomes neceſſary for the anther, and ſtigma; and this food is honey; as explained in Sect. XIII. on Vegetable Animation.

The gnat and the tadpole reſemble each other in their change from natant animals with gills into aerial animals with lungs; and in their change of the element in which they live; and probably of the food, with which they are ſupported; and laſtly, with their acquiring in their new ſtate the difference of ſex, and the organs of ſeminal or amatorial reproduction. While the polypus, who is their companion in their former ſtate of life, not being allowed to change his form and element, can only propagate like vegetable buds by the ſame kind of irritative motions, which produces the growth of his own body, without the ſeminal or amatorial propagation, which requires ſenſation, and which in gnats and tadpoles ſeems to require a change both of food and of reſpiration.

From hence I conclude, that with the acquiſition of new parts, new ſenſations, and new deſires, as well as new powers, are produced; and this by accretion to the old ones, and not by diſtention of them. And finally, that the moſt eſſential parts of the ſyſtem, as the brain for the purpoſe of diſtributing the power of life, and the placenta for the purpoſe of oxygenating the blood, and the additional abſorbent veſſels for the purpoſe of acquiring aliment, are firſt formed by the irritations above mentioned, and by the pleaſurable ſenſations attending thoſe irritations, and by the exertions in conſequence of painful ſenſations, ſimilar to thoſe of hunger and ſuffocation. After theſe an apparatus of limbs for future uſes, or for the purpoſe of moving the body in its preſent natant ſtate, and of lungs for future reſpiration, and of teſtes for future reproduction,

duction, are formed by the irritations and ſenſations, and conſequent exertions of the parts previouſly exiſting, and to which the new parts are to be attached.

3. In confirmation of theſe ideas it may be obſerved, that all the parts of the body endeavour to grow, or to make additional parts to themſelves throughout our lives; but are reſtrained by the parts immediately containing them; thus, if the ſkin be taken away, the fleſhy parts beneath ſoon ſhoot out new granulations, called by the vulgar proud fleſh, If the perioſteum be removed, a ſimilar growth commences from the bone. Now in the caſe of the imperfect embryon, the containing or confining parts are not yet ſuppoſed to be formed, and hence there is nothing to reſtrain its growth.

4. By the parts of the embryon being thus produced by new appoſitions, many phenomena both of animal and vegetable productions receive an eaſier explanation; ſuch as that many fetuſes are deficient at the extremities, as in a finger or a toe, or in the end of the tongue, or in what is called a hare-lip with deficiency of the palate. For if there ſhould be a deficiency in the quantity of the firſt nutritive particles laid up in the egg for the reception of the firſt living filament, the extreme parts, as being laſt formed, muſt ſhew this deficiency by their being imperfect.

This idea of the growth of the embryon accords alſo with the production of ſome monſtrous births, which conſiſt of a duplicature of the limbs, as chickens with four legs; which could not occur, if the fetus was formed by the diſtention of an original ſtamen, or miniature. For if there ſhould be a ſuperfluity of the firſt nutritive particles laid up in the egg for the firſt living filament; it is eaſy to conceive, that a duplicature of ſome parts may be formed. And that ſuch ſuperfluous nouriſhment ſometimes

times exiſts, is evinced by the double yolks in ſome eggs, which I ſuppoſe were thus formed previous to their impregnation by the exuberant nutriment of the hen.

This idea is confirmed by the analogy of the monſters in the vegetable world alſo; in which a duplicate or triplicate production of various parts of the flower is obſervable, as a triple nectary in ſome columbines, and a triple petal in ſome primroſes; and which are ſuppoſed to be produced by abundant nouriſhment.

5. If the embryon be received into a fluid, whoſe ſtimulus is different in ſome degree from the natural, as in the production of mule-animals, the new irritabilities or ſenſibilities acquired by the increaſing or growing organized parts may differ, and thence produce parts not ſimilar to the father, but of a kind belonging in part to the mother; and thus, though the original ſtamen or living ens was derived totally from the father, yet new irritabilities or ſenſibilities being excited, a change of form correſponding with them will be produced. Nor could the production of mules exiſt, if the ſtamen or miniature of all the parts of the embryon is previouſly formed in the male ſemen, and is only diſtended by nouriſhment in the female uterus. Whereas this difficulty ceaſes, if the embryon be ſuppoſed to conſiſt of a living filament, which acquires or makes new parts with new irritabilities, as it advances in its growth.

The form, ſolidity, and colour, of the particles of nutriment laid up for the reception of the firſt living filament, as well as their peculiar kind of ſtimulus, may contribute to produce a difference in the form, ſolidity, and colour of the fetus, ſo as to reſemble the mother, as it advances in life. This alſo may eſpecially happen during the firſt ſtate of the exiſtence of the embryon, before it has acquired

quired organs, which can change theſe firſt nutritive particles, as explained in No. 5. 2. of this Section. And as theſe nutritive particles are ſuppoſed to be ſimilar to thoſe, which are formed for her own nutrition, it follows that the fetus ſhould ſo far reſemble the mother.

This explains, why hereditary diſeaſes may be derived either from the male or female parent, as well as the peculiar form of either of their bodies. Some of theſe hereditary diſeaſes are ſimply owing to a deficient activity of a part of the ſyſtem, as of the abſorbent veſſels, which open into the cells or cavities of the body, and thus occaſion dropſies. Others are at the ſame time owing to an increaſe of ſenſation, as in ſcrophula and conſumption; in theſe the obſtruction of the fluids is firſt cauſed by the inirritability of the veſſels, and the inflammation and ulcers which ſucceed, are cauſed by the conſequent increaſe of ſenſation in the obſtructed part. Other hereditary diſeaſes, as the epilepſy, and other convulſions, conſiſt in too great voluntary exertions in conſequence of diſagreeable ſenſation in ſome particular diſeaſed part. Now as the pains, which occaſion theſe convulſions, are owing to defect of the action of the diſeaſed part, as ſhewn in Sect. XXXIV. it is plain, that all theſe hereditary diſeaſes may have their origin either from defective irritability derived from the father, or from deficiency of the ſtimulus of the nutriment derived from the mother. In either caſe the effect would be ſimilar; as a ſcrophulous race is frequently produced among the poor from the deficient ſtimulus of bad diet, or of hunger; and among the rich, by a deficient irritability from their having been long accuſtomed to too great ſtimulus, as of vinous ſpirit.

6. From this account of reproduction it appears, that all animals have a ſimilar origin, viz. from a ſingle living filament; and that the difference of their

their forms and qualities has ariſen only fromthe different irritabilities and ſenſibilities, or voluntarities, or aſſociabilities, of this original living filament; and perhaps in ſome degree from the different forms of the particles of the fluids, by which it has been at firſt ſtimulated into activity. And that from hence, as Linnæus has conjectured in reſpect to the vegetable world, it is not impoſſible, but the great variety of ſpecies of animals, which now tenant the earth, may have had their origin from the mixture of a few natural orders. And that thoſe animal and vegetable mules, which could continue their ſpecies, have done ſo, and conſtitute the numerous families of animals and vegetables which now exiſt; and that thoſe mules, which were produced with imperfect organs of generation, periſhed without reproduction, according to the obſervation of Ariſtotle; and are the animals, which we now call mules. See Botanic Garden, Part II. Note on Dianthus.

Such a promiſcuous intercourſe of animals is ſaid to exiſt at this day in New South Wales by Captain Hunter. And that not only amongſt the quadrupeds and birds of different kinds, but even amongſt the fiſh, and, as he believes, amongſt the vegetables. He ſpeaks of an animal between the opoſſum and the kangaroo, from the ſize of a ſheep to that of a rat. Many fiſh ſeemed to partake of the ſhark; ſome with a ſkait's head and ſhoulders, and the hind part of a ſhark; others with a ſhark's head and the body of a mullet; and ſome with a ſhark's head and the flat body of a ſling-ray. Many birds partake of the parrot; ſome have the head, neck, and bill of a parrot, with long ſtraight feet and legs; others with legs and feet of a parrot, with head and neck of a ſea gull. Voyage to South Wales by Captain John Hunter, p. 68.

7. All

7. All animals therefore, I contend, have a ſimilar cauſe of their organization, originating from a ſingle living filament, endued indeed with different kinds of irritabilities and ſenſibilities, or of animal appetencies; which exiſt in every gland, and in every moving organ of the body, and are as eſſential to living organization as chemical affinities are to certain combinations of inanimate matter.

If I might be indulged to make a ſimile in a philoſophical work, I ſhould ſay, that the animal appetencies are not only perhaps leſs numerous originally than the chemical affinities; but that like theſe latter, they change with every new combination; thus vital air and azote, when combined, produce nitrous acid; which now acquires the property of diſſolving ſilver; ſo with every new additional part to the embryon, as of the throat or lungs, I ſuppoſe a new animal appetency to be produced.

In this early formation of the embryon from the irritabilities, ſenſibilities, and aſſociabilities, and conſequent appetencies, the faculty of volition can ſcarcely be ſuppoſed to have had its birth. For about what can the fetus deliberate, when it has no choice of objects? But in the more advanced ſtate of the fetus, it evidently poſſeſſes volition; as it frequently changes its attitude, though it ſeems to ſleep the greateſt part of its time; and afterwards the power of volition contributes to change or alter many parts of the body during its growth to manhood, by our early modes of exertion in the various departments of life. All theſe faculties then conſtitute the vis fabricatrix, and the vis conſervatrix, as well as the vis medicatrix of nature, ſo much ſpoken of, but ſo little underſtood by philoſophers.

8. When we revolve in our minds, firſt, the great changes, which we ſee naturally produced in animals

mals after their nativity, as in the production of the butterfly with painted wings from the crawling caterpillar; or of the reſpiring frog from the ſubnatant tadpole; from the feminine body to the bearded man, and from the infant girl to the lacteſcent woman; both which changes may be prevented by certain mutilations of the glands neceſſary to reproduction.

Secondly, when we think over the great changes introduced into various animals by artificial or accidental cultivation, as in horſes, which we have exerciſed for the different purpoſes of ſtrength or ſwiftneſs, in carrying burthens or in running races; or in dogs, which have been cultivated for ſtrength and courage, as the bull-dog; or for acuteneſs of his ſenſe or ſmell, as the hound and ſpaniel; or for the ſwiftneſs of his foot, as the grey-hound; or for his ſwimming in the water, or for drawing ſnow-ſledges, as the rough-haired dogs of the north; or laſtly, as a play-dog for children, as the lap-dog; with the changes of the forms of the cattle, which have been domeſticated from the greateſt antiquity, as camels, and ſheep; which have undergone ſo total a transformation, that we are now ignorant from what ſpecies of wild animals they had their origin. Add to theſe the great changes of ſhape and colour, which we daily ſee produced in ſmaller animals from our domeſtication of them, as rabbits, or pigeons; or from the difference of climates and even of ſeaſons; thus the ſheep of warm climates are covered with hair inſtead of wool; and the hares and partridges of the latitudes, which are long buried in ſnow, become white during the winter months; add to theſe the various changes produced in the forms of mankind, by their early modes of exertion; or by the diſeaſes occaſioned by their habits of life; both of which became hereditary, and that through many generations. Thoſe who labour

labour at the anvil, the oar, or the loom, as well as thoſe who carry ſedan-chairs, or who have been educated to dance upon the rope, are diſtinguiſhable by the ſhape of their limbs; and the diſeaſes occaſioned by intoxication deform the countenance with leprous eruptions, or the body with tumid viſcera, or the joints with knots and diſtortions.

Thirdly, when we enumerate the great changes produced in the ſpecies of animals before their nativity; theſe are ſuch as reſemble the form or colour of their parents, which have been altered by the cultivation or accidents above related, and are thus continued to their poſterity. Or they are changes produced by the mixture of ſpecies, as in mules; or changes produced probably by the exuberance of nouriſhment ſupplied to the fetus, as in monſtrous births with additional limbs; many of theſe enormities of ſhape are propagated, and continued as a variety at leaſt, if not as a new ſpecies of animal. I have ſeen a breed of cats with an additional claw on every foot; of poultry alſo with an additional claw, and with wings to their feet; and of others without rumps. Mr. Buffon mentions a breed of dogs without tails, which are common at Rome and at Naples, which he ſuppoſes to have been produced by a ouſtom long eſtabliſhed of cutting their tails cloſe off. There are many kinds of pigeons, admired for their peculiarities, which are monſters thus produced and propagated. And to theſe muſt be added, the changes produced by the imagination of the male parent, as will be treated of more at large in No. VI. of this Section.

When we conſider all theſe changes of animal form, and innumerable others, which may be collected from the books of natural hiſtory; we cannot but be convinced, that the fetus or embryon is formed by appoſition of new parts, and not by the diſtention

diſtention of a primordial neſt of germs, included one within another, like the cups of a conjurer.

Fourthly, when we revolve in our minds the great ſimilarity of ſtructure, which obtains in all the warm-blooded animals, as well quadrupeds, birds, and amphibious animals, as in mankind; from the mouſe and bat to the elephant and whale; one is led to conclude, that they have alike been produced from a ſimilar living filament. In ſome this filament in its advance to maturity has acquired hands and fingers, with a fine ſenſe of touch, as in mankind. In others it has acquired claws or talons, as in tigers and eagles. In others, toes with an intervening web or membrane, as in ſeals and geeſe. In others it has acquired cloven hoofs, as in cows and ſwine; and whole hoofs in others, as in the horſe. While in the bird kind, this original living filament has put forth wings inſtead of arms or legs, and feathers inſtead of hair. In ſome it has protruded horns on the forehead inſtead of teeth in the forepart of the upper jaw; in others tuſhes inſtead of horns; and in others beaks inſtead of either. And all this exactly as is daily ſeen in the tranſmutations of the tadpole, which acquires legs and lungs, when he wants them; and loſes his tail, when it is no longer of ſervice to him.

Fifthly, from their firſt rudiment, or primordium, to the termination of their lives, all animals undergo perpetual transformations; which are in part produced by their own exertions in conſequence of their deſires and averſions, of their pleaſures and their pains, or of irritations, or of aſſociations; and many of theſe acquired forms or propenſities are tranſmitted to their poſterity. See Sect. XXXI. 1.

As air and water are ſupplied to animals in ſufficient profuſion, the three great objects of deſire, which have changed the forms of many animals by their exertions to gratify them, are thoſe of luſt, hunger,

hunger, and ſecurity. A great want of one part of the animal world has conſiſted in the deſire of the excluſive poſſeſſion of the females; and theſe have acquired weapons to combat each other for this purpoſe, as the very thick, ſhield-like, horny ſkin on the ſhoulder of the boar is a defence only againſt animals of his own ſpecies, who ſtrike obliquely upwards, nor are his tuſhes for other purpoſes, except to defend himſelf, as he is not naturally a carnivorous animal. So the horns of the ſtag are ſharp to offend his adverſary, but are branched for the purpoſe of parrying or receiving the thruſts of horns ſimilar to his own, and have therefore been formed for the purpoſe of combating other ſtags for the excluſive poſſeſſion of the females; who are obſerved, like the ladies in the times of chivalry, to attend the car of the victor.

The birds, which do not carry food to their young, and do not therefore marry, are armed with ſpurs for the purpoſe of fighting for the excluſive poſſeſſion of the females, as cocks and quails. It is certain that theſe weapons are not provided for their defence againſt other adverſaries, becauſe the females of theſe ſpecies are without this armour. The final cauſe of this conteſt amongſt the males ſeems to be, that the ſtrongeſt and moſt active animal ſhould propagate the ſpecies, which ſhould thence become improved.

Another great want conſiſts in the means of procuring food, which has diverſified the forms of all ſpecies of animals. Thus the noſe of the ſwine has become hard, for the purpoſe of turning up the ſoil in ſearch of inſects and of roots. The trunk of the elephant is an elongation of the noſe for the purpoſe of pulling down the branches of trees for his food, and for taking up water without bending his knees. Beaſts of prey have acquired ſtrong jaws or talons. Cattle have acquired a rough tongue and

and a rough palate to pull off the blades of graſs, as cows and ſheep. Some birds have acquired harder beaks to crack nuts, as the parrot. Others have acquired beaks adapted to break the harder ſeeds, as ſparrows. Others for the ſofter ſeeds of flowers, or the buds of trees, as the finches. Other birds have acquired long beaks to penetrate the moiſter ſoils in ſearch of inſects or roots, as woodcocks; and others broad ones to filtrate the water of lakes, and to retain aquatic inſects. All which ſeem to have been gradually produced during many generations by the perpetual endeavour of the creatures to ſupply the want of food, and to have been delivered to their poſterity with conſtant improvement of them for the purpoſes required.

The third great want amongſt animals is that of ſecurity, which ſeems much to have diverſified the forms of their bodies and the colour of them; theſe conſiſt in the means of eſcaping other animals more powerful than themſelves. Hence ſome animals have acquired wings inſtead of legs, as the ſmaller birds, for the purpoſe of eſcape. Others great length of fin, or of membrane, as the flying fiſh, and the bat. Others great ſwiftneſs of foot, as the hare. Others have acquired hard, or armed ſhells, as the tortoiſe and echinus marinus.

Mr. Oſbeck, a pupil of Linnæus, mentions the American frogfiſh, Lophius Hiſtrio, which inhabits the large floating iſlands of ſea weed about the Cape of Good Hope, and has fulcra reſembling leaves, that the fiſhes of prey may miſtake it for the ſea-weed, which it inhabits. Voyage to China, p. 113.

The contrivances for the purpoſes of ſecurity extend even to vegetables, as is ſeen in the wonderful and various means of their concealing or defending their honey from inſects, and their ſeeds from birds. On the other hand ſwiftneſs of wing has been acquired by hawks and ſwallows to purſue their prey;

and a proboſcis of admirable ſtructure has been acquired by the bee, the moth, and the humming bird, for the purpoſe of plundering the nectaries of flowers. All which ſeem to have been formed by the original living filament, excited into action by the neceſſities of the creatures, which poſſeſs them, and on which their exiſtence depends.

From thus meditating on the great ſimilarity of the ſtructure of the warm-blooded animals, and at the ſame time of the great changes they undergo both before and after their nativity; and by conſidering in how minute a portion of time many of the changes of animals above deſcribed have been produced; would it be too bold to imagine, that in the great length of time, ſince the earth began to exiſt, perhaps millions of ages before the commencement of the hiſtory of mankind, would it be too bold to imagine, that all warm-blooded animals have ariſen from one living filament, which the GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts, attended with new propenſities, directed by irritations, ſenſations, volitions, and aſſociations; and thus poſſeſſing the faculty of continuing to improve by its own inherent activity, and of delivering down thoſe improvements by generation to its poſterity, world without end!

Sixthly, The cold-blooded animals, as the fiſh-tribes, which are furniſhed with but one ventricle of the heart, and with gills inſtead of lungs, and with fins inſtead of feet or wings, bear a great ſimilarity to each other; but they differ, nevertheleſs, ſo much in their general ſtructure from the warm-blooded animals, that it may not ſeem probable at firſt view, that the ſame living filament could have given origin to this kingdom of animals, as to the former. Yet are there ſome creatures, which unite or partake of both theſe orders of animation, as the whales and ſeals; and more particularly the frog, who

who changes from an aquatic animal furniſhed with gills to an aerial one furniſhed with lungs.

The numerous tribes of inſects without wings, from the ſpider to the ſcorpion, from the flea to the lobſter; or with wings, from the gnat and the ant to the waſp and the dragon-fly, differ ſo totally from each other, and from the red-blooded claſſes above deſcribed, both in the forms of their bodies, and their modes of life; beſides the organ of ſenſe, which they ſeem to poſſeſs in their antennæ or horns, to which it has been thought by ſome naturaliſts, that other creatures have nothing ſimilar; that it can ſcarcely be ſuppoſed that this nation of animals could have been produced by the ſame kind of living filament, as the red-blooded claſſes above mentioned. And yet the changes which many of them undergo in their early ſtate to that of their maturity, are as different, as one animal can be from another. As thoſe of the gnat, which paſſes his early ſtate in water, and then ſtretching out his new wings, and expanding his new lungs, riſes in the air; as of the caterpillar, and bee-nymph, which feed on vegetable leaves or farina, and at length burſting from their ſelf-formed graves, become beautiful winged inhabitants of the ſkies, journeying from flower to flower, and nouriſhed by the ambroſial food of honey.

There is ſtill another claſs of animals, which are termed vermes by Linnæus, which are without feet, or brain, and are hermaphrodites, as worms, leeches, ſnails, ſhell-fiſh, coralline inſects, and ſponges; which poſſeſs the ſimpleſt ſtructure of all animals, and appear totally different from thoſe already deſcribed. The ſimplicity of their ſtructure, however, can afford no argument againſt their having been produced from a living filament as above contended.

Laſt of all the various tribes of vegetables are to be enumerated amongſt the inferior orders of ani-

mals. Of theſe the anthers and ſtigmas have already been ſhewn to poſſeſs ſome organs of ſenſe, to be nouriſhed by honey, and to have the power of generation like inſects, and have thence been announced amongſt the animal kingdom in Sect. XIII. and to theſe muſt be added the buds and bulbs which conſtitute the viviparous offspring of vegetation. The former I ſuppoſe to be beholden to a ſingle living filament for their ſeminal or amatorial procreation; and the latter to the ſame cauſe for their lateral or branching generation, which they poſſeſs in common with the polypus, tænia, and volvox; and the ſimplicity of which is an argument in favour of the ſimilarity of its cauſe.

Linnæus ſuppoſes, in the Introduction to his Natural Orders, that very few vegetables were at firſt created, and that their numbers were increaſed by their intermarriages, and adds, ſuadent hæc Creatoris leges a ſimplicibus ad compoſita. Many other changes ſeem to have ariſen in them by their perpetual conteſt for light and air above ground, and for food or moiſture beneath the ſoil. As noted in Botanic Garden, Part II. Note on Cuſcuta. Other changes of vegetables from climate, or other cauſes, are remarked in the Note on Curcuma in the ſame work. From theſe one might be led to imagine, that each plant at firſt conſiſted of a ſingle bulb, or flower to each root, as the gentianella and daiſy; and that in the conteſt for air and light, new buds grew on the old decaying flower ſtem, ſhooting down their elongated roots to the ground, and that in proceſs of ages tall trees were thus formed, and an individual bulb became a ſwarm of vegetables. Other plants, which in this conteſt for light and air were too ſlender to riſe by their own ſtrength, learned by degrees to adhere to their neighbours, either by putting forth roots like the ivy, or by tendrils like the vine, or by ſpiral contortions like the honeyſuckle;

ſuckle; or by growing upon them like the miſleto, and taking nouriſhment from their barks; or by only lodging or adhering on them, and deriving nouriſhment from the air, as tillandſia.

Shall we then ſay the vegetable living filament was originally different from that of each tribe of animals above deſcribed? And that the productive living filament of each of thoſe tribes was different originally from the other? Or, as the earth and ocean were probably peopled with vegetable productions long before the exiſtence of animals; and many families of theſe animals long before other families of them, ſhall we conjecture that one and the ſame kind of living filaments is and has been the cauſe of all organic life?

This idea of the gradual formation and improvement of the animal world accords with the obſervations of ſome modern philoſophers, who have ſuppoſed that the continent of America has been raiſed out of the ocean at a later period of time than the other three quarters of the globe, which they deduce from the greater comparative heights of its mountains, and the conſequent greater coldneſs of its reſpective climates, and from the leſs ſize and ſtrength of its animals, as the tigers and alligators compared with thoſe of Aſia or Africa. And laſtly, from the leſs progreſs in the improvements of the mind of its inhabitants in reſpect to voluntary exertions.

This idea of the gradual formation and improvement of the animal world ſeems not to have been unknown to the ancient philoſophers. Plato having probably obſerved the reciprocal generation of inferior animals, as ſnails and worms, was of opinion, that mankind with all other animals were originally hermaphrodites during the infancy of the world, and were in proceſs of time ſeparated into male and female. The breaſts and teats of all male quadrupeds,

peds, to which no uſe can now be aſſigned, adds perhaps ſome ſhadow of probability to this opinion. Linnæus excepts the horſe from the male quadrupeds, who have teats; which might have ſhewn the earlier origin of his exiſtence; but Mr. J. Hunter aſſerts, that he has diſcovered the veſtiges of them on his ſheath, and has at the ſame time enriched natural hiſtory with a very curious fact concerning the male pigeon; at the time of hatching the eggs both the male and female pigeon undergo a great change in their crops; which thicken and become corrugated, and ſecrete a kind of milky fluid, which coagulates, and with which alone they for a few days feed their young, and afterwards feed them with this coagulated fluid mixed with other food. How this reſembles the breaſts of female quadrupeds after the production of their young! and how extraordinary, that the male ſhould at this time give milk as well as the female! See Botanic Garden, Part II. Note on Curcuma.

The late Mr. David Hume, in his poſthumous works, places the powers of generation much above thoſe of our boaſted reaſon; and adds, that reaſon can only make a machine, as a clock or a ſhip, but the power of generation makes the maker of the machine; and probably from having obſerved, that the greateſt part of the earth has been formed out of organic recrements; as the immenſe beds of limeſtone, chalk, marble, from the ſhells of fiſh; and the extenſive provinces of clay, ſandſtone, ironſtone, coals, from decompoſed vegetables; all which have been firſt produced by generation, or by the ſecretions of organic life; he concludes that the world itſelf might have been generated, rather than created; that is, it might have been gradually produced from very ſmall beginnings, increaſing by the activity of its inherent principles, rather than by a ſudden evolution of the whole by the Almighty

mighty fire.—What a magnificent idea of the infinite power of THE GREAT ARCHITECT! THE CAUSE OF CAUSES! PARENT OF PARENTS! ENS ENTIUM!

For if we may compare infinities, it would ſeem to require a greater infinity of power to cauſe the cauſes of effects, than to cauſe the effects themſelves. This idea is analogous to the improving excellence obſervable in every part of the creation; ſuch as in the progreſſive increaſe of the ſolid or habitable parts of the earth from water; and in the progreſſive increaſe of the wiſdom and happineſs of its inhabitants; and is conſonant to the idea of our preſent ſituation being a ſtate of probation, which by our exertions we may improve, and are conſequently reſponſible for our actions.

V. 1. The efficient cauſe of the various colours of the eggs of birds, and of the hair and feathers of animals, is a ſubject ſo curious, that I ſhall beg to introduce it in this place. The colours of many animals ſeem adapted to their purpoſes of concealing themſelves either to avoid danger, or to ſpring upon their prey. Thus the ſnake and wild cat, and leopard, are ſo coloured as to reſemble dark leaves and their lighter interſtices; birds reſemble the colour of the brown ground, or the green hedges, which they frequent; and moths and butterflies are coloured like the flowers which they rob of their honey. Many inſtances are mentioned of this kind in Botanic Garden, p. 2. Note on Rubia.

Theſe colours have, however, in ſome inſtances another uſe, as the black diverging area from the eyes of the ſwan; which, as his eyes are placed leſs prominent than thoſe of other birds, for the convenience of putting down his head under water, prevents the rays of light from being reflected into his eye, and thus dazzling his ſight, both in air and beneath the water; which muſt have happened, if

that

that ſurface had been white like the reſt of his feathers.

There is a ſtill more wonderful thing concerning theſe colours adapted to the purpoſe of concealment; which is, that the eggs of birds are ſo coloured as to reſemble the colour of the adjacent objects and their interſtices. The eggs of hedge-birds are greeniſh with dark ſpots; thoſe of crows and magpies, which are ſeen from beneath through wicker neſts, are white with dark ſpots; and thoſe of larks and partridges are ruſſet or brown, like their neſts or ſituations.

A thing ſtill more aſtoniſhing is, that many animals in countries covered with ſnow become white in winter, and are ſaid to change their colour again in the warmer months, as bears, hares, and partridges. Our domeſticated animals loſe their natural colours, and break into great variety, as horſes, dogs, pigeons. The final cauſe of theſe colours is eaſily underſtood, as they ſerve ſome purpoſes of the animal, but the efficient cauſe would ſeem almoſt beyond conjecture.

Firſt, the choroid coat of the eye, on which the ſemitranſparent retina is expanded, is of different colour in different animals; in thoſe which feed on graſs it is green; from hence there would appear ſome connexion between the colour of the choroid coat and of that conſtantly painted on the retina by the green graſs. Now, when the ground becomes covered with ſnow, it would ſeem, that that action of the retina, which is called whiteneſs, being conſtantly excited in the eye, may be gradually imitated by the extremities of the nerves of touch, or rete mucoſum of the ſkin. And if it be ſuppoſed, that the action of the retina in producing the perception of any colour conſiſts in ſo diſpoſing its own fibres or ſurface, as to reflect thoſe coloured rays only, and tranſmit the others like ſoap-bubbles;

bles; then that part of the retina, which gives us the perception of ſnow, muſt at that time be white; and that which gives us the perception of graſs, muſt be green.

Then if by the laws of imitation, as explained in Section XII. 33. and XXXIX. 6. the extremities of the nerves of touch in the rete mucoſum be induced into ſimilar action, the ſkin or feathers, or hair, may in like manner ſo diſpoſe their extreme fibres, as to reflect white; for it is evident, that all theſe parts were originally obedient to irritative motions during their growth, and probably continue to be ſo; that thoſe irritative motions are not liable in a healthy ſtate to be ſucceeded by ſenſation; which however is no uncommon thing in their diſeaſed ſtate, or in their infant ſtate, as in plica polonica, and in very young pen-feathers, which are ſtill full of blood.

It was ſhewn in Section XV. on the Production of Ideas, that the moving organ of ſenſe in ſome circumſtances reſembled the object which produced that motion. Hence it may be conceived, that the rete mucoſum, which is the extremity of the nerves of touch, may by imitating the motions of the retina become coloured. And thus, like the fable of the camelion, all animals may poſſeſs a tendency to be coloured ſomewhat like the colours they moſt frequently inſpect; and finally, that colours may be thus given to the egg-ſhell by the imagination of the female parent; which ſhell is previouſly a mucous membrane, indued with irritability, without which it could not circulate its fluids, and increaſe in its bulk. Nor is this more wonderful than that a ſingle idea of imagination ſhould in an inſtant colour the whole ſurface of the body of a bright ſcarlet, as in the bluſh of ſhame, though by a very different proceſs. In this intricate ſubject nothing but looſe analogical conjectures can be had, which may

may however lead to future diſcoveries; but certain it is that both the change of the colour of animals to white in the winters of ſnowy countries, and the ſpots on birds eggs, muſt have ſome efficient cauſe; ſince the uniformity of their production ſhews it cannot ariſe from a fortuitous concurrence of circumſtances; and how is this efficient cauſe to be detected, or explained, but from its analogy to other animal facts?

2. The nutriment ſupplied by the female parent in viviparous animals to their young progeny may be divided into three kinds, correſponding with the age of the new creature. 1. The nutriment contained in the ovum as previouſly prepared for the embryon in the ovary. 2. The liquor amnii prepared for the fetus in the uterus, and in which it ſwims; and laſtly, the milk prepared in the pectoral glands for the new born child. There is reaſon to conclude, that variety of changes may be produced in the new animal from all theſe ſources of nutriment, but particularly from the firſt of them.

The organs of digeſtion and of ſanguification in adults, and afterwards thoſe of ſecretion, prepare or ſeparate the particles proper for nouriſhment from other combinations of matter, or recombine them into new kinds of matter, proper to excite into action the filaments, which abſorb or attract them by animal appetency. In this proceſs we muſt attend not only to the action of the living filament, which receives a nutritive particle to its boſom, but alſo to the kind of particle, in reſpect to form, or ſize, or colour, or hardneſs, which is thus previouſly prepared for it by digeſtion, ſanguification, and ſecretion. Now as the firſt filament of entity cannot be furniſhed with the preparative organs above mentioned, the nutritive particles, which are at firſt to be received by it, are prepared by the mother; and depoſited in the ovum ready for its reception

reception. Theſe nutritive particles muſt be ſuppoſed to differ in ſome reſpects, when thus prepared by different animals. They may differ in ſize, colour, and form; and yet may be ſufficiently congenial to the living filament, to which they are applied, as to excite its activity by their ſtimulus, and its animal appetency to receive them, and to combine them with itſelf into organization.

By this firſt nutriment thus prepared for the embryon is not meant the liquor amnii, which is afterwards produced, nor the larger exterior parts of the white of the egg; but the fluid prepared, I ſuppoſe, in the ovary of viviparous animals, and that which immediately ſurrounds the cicatricula of an impregnated egg, and is viſible to the eye in a boiled one.

Now theſe ultimate particles of animal matter prepared by the glands of the mother may be ſuppoſed to reſemble the ſimilar ultimate particles, which were prepared for her own nouriſhment; that is, to the ultimate particles of which her own organization conſiſts. And that hence when theſe become combined with a new embryon, which in its early ſtate is not furniſhed with ſtomach, or glands, to alter them; that new embryon will bear ſome reſemblance to the mother.

This ſeems to be the origin of the compound forms of mules, which evidently partake of both parents, but principally of the male parent. In this production of chimeras the antients ſeem to have indulged their fancies, whence the ſphinxes, griffins, dragons, centaurs, and minotaurs, which are vaniſhed from modern credulity.

It would ſeem, that in theſe unnatural conjunctions, when the nutriment depoſited by the female was ſo ill adapted to ſtimulate the living filament derived from the male into action, and to be received, or embraced by it, and combined with it into

into organization, as not to produce the organs neceſſary to life, as the brain, or heart, or ſtomach, that no mule was produced. Where all the parts neceſſary to life in theſe compound animals were formed ſufficiently perfect, except the parts of generation, thoſe animals were produced which are now called mules.

The formation of the organs of ſexual generation, in contradiſtinction to that by lateral buds, in vegetables, and in ſome animals, as the polypus, the tænia, and the volvox, ſeems the chef d'œuvre, the maſter-piece of nature; as appears from many flying inſects, as in moths and butterflies, who ſeem to undergo a general change of their forms ſolely for the purpoſe of ſexual reproduction, and in all other animals this organ is not complete till the maturity of the creature. Whence it happens that, in the copulation of animals of different ſpecies, the parts neceſſary to life are frequently completely formed; but thoſe for the purpoſe of generation are defective, as requiring a nicer organization; or more exact coincidence of the particles of nutriment to the irritabilities or appetencies of the original living filament. Whereas thoſe mules, where all the parts could be perfectly formed, may have been produced in earlier periods of time, and may have added to the numbers of our various ſpecies of animals, as before obſerved.

As this production of mules is a conſtant effect from the conjunction of two different ſpecies of animals, thoſe between the horſe and the female aſs always reſembling the horſe more than the aſs; and thoſe, on the contrary, between the male aſs and the mare, always reſembling the aſs more than the mare; it cannot be aſcribed to the imagination of the male animal which cannot be ſuppoſed to operate ſo uniformly; but to the form of the firſt nutritive particles, and to their peculiar ſtimulus exciting the living

living filament to ſelect and combine them with itſelf. There is a ſimilar uniformity of effect in reſpect to the colour of the progeny produced between a white man, and a black woman, which, if I am well informed, is always of the mulatto kind, or a mixture of the two; which may perhaps be imputed to the peculiar form of the particles of nutriment ſupplied to the embryon by the mother at the early period of its exiſtence, and their peculiar ſtimulus; as this effect, like that of the mule progeny above treated of, is uniform and conſiſtent, and cannot therefore be aſcribed to the imagination of either of the parents.

Dr. Thunberg obſerves, in his Journey to the Cape of Good Hope, that there are ſome families, which have deſcended from blacks in the female line for three generations. The firſt generation proceeding from an European, who married a tawny ſlave, remains tawny, but approaches to a white complexion; but the children of the third generation, mixed with Europeans, become quite white, and are often remarkably beautiful. V. i. p. 112.

When the embryon has produced a placenta, and furniſhed itſelf with veſſels for ſelection of nutritious particles, and for oxygenation of them, no great change in its form or colour is likely to be produced by the particles of ſuſtenance it now takes from the fluid, in which it is immerſed; becauſe it has now acquired organs to alter or new combine them. Hence it continues to grow, whether this fluid, in which it ſwims, be formed by the uterus or by any other cavity of the body, as in extrauterine geſtation; and which would ſeem to be produced by the ſtimulus of the fetus on the ſides of the cavity, where it is found, as mentioned before. And thirdly, there is ſtill leſs reaſon to expect any unnatural change to happen to the child after its birth from the difference of the milk it now takes; becauſe

becauſe it has acquired a ſtomach, and lungs, and glands, of ſufficient power to decompoſe and recombine the milk; and thus to prepare from it the various kinds of nutritious particles, which the appetencies of the various fibrils or nerves may require.

From all this reaſoning I would conclude, that though the imagination of the female may be ſuppoſed to affect the embryon by producing a difference in its early nutriment; yet that no ſuch power can affect it after it has obtained a placenta, and other organs; which may ſelect or change the food, which is preſented to it either in the liquor amnii, or in the milk. Now as the eggs in pullets, like the ſeeds in vegetables, are produced gradually, long before they are impregnated, it does not appear how any ſudden effect of imagination of the mother, at the time of impregnation, can produce any conſiderable change in the nutriment already thus laid up for the expected or deſired embryon. And that hence any changes of the embryon, except thoſe uniform ones in the production of mules and mulattoes, more probably depend on the imagination of the male parent. At the ſame time it ſeems manifeſt, that thoſe monſtrous births, which conſiſt in ſome deficiencies only, or ſome redundancies of parts, originate from the deficiency or redundance of the firſt nutriment prepared in the ovary, or in the part of the egg immediately ſurrounding the cicatricula, as deſcribed above; and which continues ſome time to excite the firſt living filament into action, after the ſimple animal is completed; or ceaſes to excite it, before the complete form is accompliſhed. The former of theſe circumſtances is evinced by the eggs with double yolks, which frequently happen to our domeſticated poultry, and which, I believe, are ſo formed before impregnation, but which would be well worth attending to,

both

both before and after impregnation; as it is probable, ſomething valuable on this ſubject might be learnt from them. The latter circumſtance, or that of deficiency of original nutriment, may be deduced from reverſe analogy.

There are, however, other kinds of monſtrous births, which neither depend on deficiency of parts, or ſupernumerary ones; nor are owing to the conjunction of animals of different ſpecies; but which appear to be new conformations, or new diſpoſitions of parts in reſpect to each other, and which, like the variation of colours and forms of our domeſticated animals, and probably the ſexual parts of all animals, may depend on the imagination of the male parent, which we now come to conſider.

VI. 1. The nice actions of the extremities of our various glands are exhibited in their various productions, which are believed to be made by the gland, and not previouſly to exiſt as ſuch in the blood. Thus the glands, which conſtitute the liver, make bile; thoſe of the ſtomach make gaſtric acid; thoſe beneath the jaw, ſaliva; thoſe of the ears, ear-wax, and the like. Every kind of gland muſt poſſeſs a peculiar irritability, and probably a ſenſibility, at the early ſtate of its exiſtence; and muſt be furniſhed with a nerve of ſenſe, or of motion, to perceive, and to ſelect, and to combine the particles, which compoſe the fluid it ſecretes. And this nerve of ſenſe which perceives the different articles which compoſe the blood, muſt at leaſt be conceived to be as fine and ſubtle an organ, as the optic or auditory nerve, which perceive light or ſound. See Sect. XIV. 9.

But in nothing is this nice action of the extremities of the blood-veſſels ſo wonderful, as in the production of contagious matter. A ſmall drop of variolous contagion diffuſed in the blood, or perhaps only by being inſerted beneath the cuticle, after

after a time, (as about a quarter of a lunation,) excites the extreme veſſels of the ſkin into certain motions, which produce a ſimilar contagious material, filling with it a thouſand puſtules. So that by irritation, or by ſenſation in conſequence of irritation, or by aſſociation of motions, a material is formed by the extremities of certain cutaneous veſſels, exactly ſimilar to the ſtimulating material, which cauſed the irritation, or conſequent ſenſation, or aſſociation.

Many glands of the body have their motions, and in conſequence their ſecreted fluids, affected by pleaſurable or painful ideas, ſince they are in many inſtances influenced by ſenſitive aſſociations, as well as by the irritations of the particles of the paſſing blood. Thus the idea of meat, excited in the minds of hungry dogs, by their ſenſe of viſion, or of ſmell, increaſes the diſcharge of ſaliva, both in quantity and viſcidity; as is ſeen in its hanging down in threads from their mouths, as they ſtand round a dinner-table. The ſenſations of pleaſure, or of pain, of peculiar kinds, excite in the ſame manner a great diſcharge of tears; which appear alſo to be more ſaline at the time of their ſecretion, from their inflaming the eyes and eye-lids. The paleneſs from fear, and the bluſh of ſhame, and of joy, are other inſtances of the effects of painful, or pleaſurable ſenſations, on the extremities of the arterial ſyſtem.

It is probable, that the pleaſurable ſenſation excited in the ſtomach by food, as well as its irritation, contributes to excite into action the gaſtric glands, and to produce a greater ſecretion of their fluids. The ſame probably occurs in the ſecretion of bile; that is, that the pleaſurable ſenſation excited in the ſtomach, affects this ſecretion by ſenſitive aſſociation, as well as by irritative aſſociation.

And laſtly it would ſeem, that all the glands in the body have their ſecreted fluids affected, in quantity

tity and quality, by the pleaſurable or painful ſenſations, which produce or accompany thoſe ſecretions. And that the pleaſurable ſenſations ariſing from theſe ſecretions may conſtitute the unnamed pleaſure of exiſtence, which is contrary to what is meant by tædium vitæ, or ennui; and by which we ſometimes feel ourſelves happy, without being able to aſcribe it to any mental cauſe, as after an agreeable meal, or in the beginning of intoxication.

Now it would appear, that no ſecretion or excretion of fluid is attended with ſo much agreeable ſenſation, as that of the ſemen; and it would thence follow, that the glands, which perform this ſecretion, are more likely to be much affected by their catenations with pleaſurable ſenſations. This circumſtance is certain, that much more of this fluid is produced in a given time, when the object of its excluſion is agreeable to the mind.

2. A forcible argument, which ſhews the neceſſity of pleaſurable ſenſation to copulation, is, that the act cannot be performed without it; it is eaſily interrupted by the pain of fear or baſhfulneſs; and no efforts of volition or of irritation can effect this proceſs, except ſuch as induce pleaſurable ideas of ſenſations. See Sect. XXXIII. 1. 1.

A curious analogical circumſtance attending hermaphrodite inſects, as ſnails and worms, ſtill further illuſtrates this theory; if the ſnail or worm could have impregnated itſelf, there might have been a ſaving of a large male apparatus; but as this is not ſo ordered by nature, but each ſnail and worm receives and gives impregnation, it appears, that a pleaſurable excitation ſeems alſo to have been required.

This wonderful circumſtance of many inſects being hermaphrodites, and at the ſame time not having power to impregnate themſelves, is attended to by Dr. Liſter, in his Exercitationes Anatom. de

Limacibus, p. 145; who, amongſt many other final cauſes, which he adduces to account for it, adds, ut tam triſtibus et frigidis animalibus majori cum voluptate perficiatur venus.

There is, however, another final cauſe, to which this circumſtance may be imputed: it was obſerved above, that vegetable buds and bulbs, which are produced without a mother, are always exact reſemblances of their parent; as appears in grafting fruit-trees, and in the flower-buds of the dioiceous plants, which are always of the ſame ſex on the ſame tree; hence thoſe hermaphrodite inſects, if they could have produced young without a mother, would not have been capable of that change or improvement, which is ſeen in all other animals, and in thoſe vegetables, which are procreated by the male embryon received and nouriſhed by the female. And it is hence probable, if vegetables could only have been produced by buds and bulbs, and not by ſexual generation, that there would not at this time have exiſted one thouſandth part of their preſent number of ſpecies; which have probably been originally mule-productions; nor could any kind of improvement or change have happened to them, except by the difference of ſoil or climate.

3. I conclude, that the imagination of the male at the time of copulation, or at the time of the ſecretion of the ſemen, may ſo affect this ſecretion by irritative or ſenſitive aſſociation, as deſcribed in No. 5. 1. of this Section, as to cauſe the production of ſimilarity of form and of features, with the diſtinction of ſex; as the motions of the chiſſel of the turner imitate or correſpond with thoſe of the ideas of the artiſt. It is not here to be underſtood, that the firſt living fibre, which is to form an animal, is produced with any ſimilarity of form to the future animal; but with propenſities, or appetences, which ſhall produce by accretion of parts the ſimilarity of form,

form, feature, or ſex, correſponding to the imagination of the father.

Our ideas are movements of the nerves of ſenſe, as of the optic nerve in recollecting viſible ideas, ſuppoſe of a triangular piece of ivory. The fine moving fibres of the retina act in a manner to which I give the name of white; and this action is confined to a defined part of it; to which figure I give the name of triangle. And it is a preceding pleaſurable ſenſation exiſting in my mind, which occaſions me to produce this particular motion of the retina, when no triangle is preſent. Now it is probable, that the acting fibres of the ultimate terminations of the ſecreting apertures of the veſſels of the teſtes, are as fine as thoſe of the retina; and that they are liable to be thrown into that peculiar action, which marks the ſex of the ſecreted embryon, by ſympathy with the pleaſurable motions of the nerves of viſion or of touch; that is, with certain ideas of imagination. From hence it would appear, that the world has been long miſtaken in aſcribing great power to the imagination of the female, whereas from this account of it, the real power of imagination, in the act of generation, belongs ſolely to the male. See Sect. XII. 3. 3.

It may be objected to this theory, that a man may be ſuppoſed to have in his mind, the idea of the form and features of the female, rather than his own, and therefore there ſhould be a greater number of female births. On the contrary, the general idea of our own form occurs to every one almoſt perpetually, and is termed conſciouſneſs of our exiſtence, and thus may effect, that the number of males ſurpaſſes that of females. See Sect. XV. 3. 4. and XVIII. 13. And what further confirms this idea is, that the male children moſt frequently reſemble the father in form, or feature, as well as in ſex; and the female moſt frequently reſemble the

mother, in feature, and form, as well as in ſex.

It may again be objected, if a female child ſometimes reſembles the father, and a male child the mother, the ideas of the father, at the time of procreation, muſt ſuddenly change from himſelf to the mother, at the very inſtant, when the embryon is ſecreted or formed. This difficulty ceaſes when we conſider, that it is as eaſy to form an idea of feminine features with male organs of reproduction, or of male features with female ones, as the contrary; as we conceive the idea of a ſphinx or mermaid as eaſily and as diſtinctly as of a woman. Add to this, that at the time of procreation the idea of the male organs, and of the female features, are often both excited at the ſame time, by contact, or by viſion.

I aſk, in my turn, is the ſex of the embryon produced by accident? Certainly whatever is produced has a cauſe; but when this cauſe is too minute for our comprehenſion, the effect is ſaid in common language to happen by chance, as in throwing a certain number on dice. Now what cauſe can occaſionally produce the male or female character of the embryon, but the peculiar actions of thoſe glands, which form the embryon? And what can influence or govern theſe actions of the gland, but its aſſociations or catenations with other ſenſitive motions? Nor is this more extraordinary, than that the catenations of irritative motions with the apparent vibrations of objects at ſea ſhould produce ſickneſs of the ſtomach, or that a nauſeous ſtory ſhould occaſion vomiting.

4. An argument, which evinces the effect of imagination on the firſt rudiment of the embryon, may be deduced from the production of ſome peculiar monſters. Such, for inſtance, as thoſe which have two heads joined to one body, and thoſe which have two bodies joined to one head; of which frequent examples occur amongſt our domeſticated quadrupeds,

peds, and poultry. It is abſurd to ſuppoſe, that ſuch forms could exiſt in primordial germs, as explained in No. IV. 4. of this Section. Nor is it poſſible, that ſuch deformities could be produced by the growth of two embryons, or living filaments; which ſhould afterwards adhere together; as the head and tail part of different polypi are ſaid to do (Blumenbach on Generation, Cadel, London); ſince in that caſe one embryon, or living filament, muſt have begun to form one part firſt, and the other another part firſt. But ſuch monſtrous conformations become leſs difficult to comprehend, when they are conſidered as an effect of the imagination, as before explained, on the living filament at the time of its ſecretion; and that ſuch duplicature of limbs were produced by accretion of new parts, in conſequence of propenſities, or animal appetencies thus acquired from the female parent.

For inſtance, I can conceive, if a turkey-cock ſhould behold a rabbit, or a frog, at the time of procreation, that it might happen, that a forcible or even a pleaſurable idea of the form of a quadruped might ſo occupy his imagination, as to cauſe a tendency in the naſcent filament to reſemble ſuch a form, by the appoſition of a duplicature of limbs. Experiments on the production of mules and monſters would be worthy the attention of a Spallanzani, and might throw much light upon this ſubject, which at preſent muſt be explained by conjectural analogies.

The wonderful effect of imagination, both in the male and female parent, is ſhewn in the production of a kind of milk in the crops both of the male and female pigeons after the birth of their young, as obſerved by Mr. Hunter, and mentioned before. To this ſhould be added, that there are ſome inſtances of men having had milk ſecreted in their breaſts, and who have given ſuck to children, as recorded by

by Mr. Buffon. This effect of imagination, of both the male and female parent, ſeems to have been attended to in very early times; Jacob is ſaid not only to have placed rods of trees, in part ſtripped of their bark, ſo as to appear ſpotted, but alſo to have placed ſpotted lambs before the flocks, at the time of their copulation. Geneſis, chap. xxx. verſe 40.

5. In reſpect to the imagination of the mother, it is difficult to comprehend, how this can produce any alteration in the fetus, except by affecting the nutriment laid up for its firſt reception, as deſcribed in No. V. 2. of this ſection, or by affecting the nouriſhment or oxygenation with which ſhe ſupplies it afterwards. Perpetual anxiety may probably affect the ſecretion of the liquor amnii into the uterus, as it enfeebles the whole ſyſtem; and ſudden fear is a frequent cauſe of miſcarriage; for fear, contrary to joy, decreaſes for a time the action of the extremities of the arterial ſyſtem; hence ſudden paleneſs ſucceeds, and a ſhrinking or contraction of the veſſels of the ſkin, and other membranes. By this circumſtance, I imagine, the terminations of the placental veſſels are detached from their adheſions, or inſertions, into the membrane of the uterus; and the death of the child ſucceeds, and conſequent miſcarriage.

Of this I recollect a remarkable inſtance, which could be aſcribed to no other cauſe, and which I ſhall therefore relate in few words. A healthy young woman, about twenty years of age, had been about five months pregnant, and going down into her cellar to draw ſome beer, was frighted by a ſervant boy ſtarting up from behind the barrel, where he had concealed himſelf with deſign to alarm the maid ſervant, for whom he miſtook his miſtreſs. She came with difficulty up ſtairs, began to flood immediately, and miſcarried in a few hours. She has ſince borne ſeveral children, nor ever had any tendency to miſcarry of any of them.

In

In reſpect to the power of the imagination of the male over the form, colour, and ſex of the progeny, the following inſtances have fallen under my obſervation, and may perhaps be found not very unfrequent, if they were more attended to. I am acquainted with a gentleman, who has one child with dark hair and eyes, though his lady and himſelf have light hair and eyes; and their other four children are like their parents. On obſerving this diſſimilarity of one child to the others he aſſured me, that he believed it was his own imagination, that produced the difference; and related to me the following ſtory. He ſaid, that when his lady lay in of her third child, he became attached to a daughter of one of his inferior tenants, and offered her a bribe for her favours in vain; and afterwards a greater bribe, and was equally unſucceſsful; that the form of this girl dwelt much in his mind for ſome weeks, and that the next child, which was the dark-ey'd young lady above mentioned, was exceedingly like, in both features and colour, to the young woman who refuſed his addreſſes.

To this inſtance I muſt add, that I have known two families, in which, on account of an intailed eſtate in expectation, a male heir was moſt eagerly deſired by the father; and on the contrary, girls were produced to the ſeventh in one, and to the ninth in another; and then they had each of them a ſon. I conclude, that the great deſire of a male heir by the father produced rather a diſagreeable than an agreeable ſenſation; and that his ideas dwelt more on the fear of generating a female, than on the pleaſurable ſenſations or ideas of his own male form or organs at the time of copulation, or of the ſecretion of the ſemen; and that hence the idea of the female character was more preſent to his mind than that of the male one; till at length in deſpair of generating

nerating a male theſe ideas ceaſed, and thoſe of the male character preſided at the genial hour.

7. Hence I conclude, that the act of generation cannot exiſt without being accompanied with ideas, and that a man muſt have at that time either a general idea of his own male form, or of the form of his male organs; or an idea of the female form, or of her organs; and that this marks the ſex, and the peculiar reſemblances of the child to either parent. From whence it would appear, that the phalli, which were hung round the necks of the Roman ladies, or worn in their hair, might have effect in producing a greater proportion of male children; and that the callipædia, or art of begetting beautiful children, and of procreating either males or females, may be taught by affecting the imagination of the male-parent; that is, by the fine extremities of the ſeminal glands imitating the actions of the organs of ſenſe either of ſight or touch. But the manner of accompliſhing this cannot be unfolded with ſufficient delicacy for the public eye; but may be worth the attention of thoſe, who are ſeriouſly intereſted in the procreation of a male or female child.

Recapitulation.

VII. 1. A certain quantity of nutritive particles are produced by the female parent before impregnation, which require no further digeſtion, ſecretion, or oxygenation. Such are ſeen in the unimpregnated eggs of birds, and in the unimpregnated ſeed-veſſels of vegetables.

2. A living filament is produced by the male, which being inſerted amidſt theſe firſt nutritive particles, is ſtimulated into action by them; and in conſequence of this action, ſome of the nutritive particles are embraced, and added to the original living filament;

filament; in the ſame manner as common nutrition is performed in the adult animal.

3. Then this new organization, or additional part, becomes ſtimulated by the nutritive particles in its vicinity, and ſenſation is now ſuperadded to irritation; and other particles are in conſequence embraced, and added to the living filament; as is ſeen in the new granulations of fleſh in ulcers.

By the power of aſſociation, or by irritation, the parts already produced continue their motions, and new ones are added by ſenſation, as above mentioned; and laſtly by volition, which laſt ſenſorial power is proved to exiſt in the fetus in its maturer age, becauſe it has evidently periods of activity and of ſleeping; which laſt is another word for a temporary ſuſpenſion of volition.

The original living filament may be conceived to poſſeſs a power of repulſing the particles applied to certain parts of it, as well as of embracing others, which ſtimulate other parts of it; as theſe powers exiſt in different parts of the mature animal; thus the mouth of every gland embraces the particles or fluid, which ſuits its appetency; and its excretory duct repulſes thoſe particles, which are diſagreeable to it.

4. Thus the outline or miniature of the new animal is produced gradually, but in no great length of time; becauſe the original nutritive particles require no previous preparation by digeſtion, ſecretion, and oxygenation: but require ſimply the ſelection and appoſition, which is performed by the living filament. Mr. Blumenbach ſays, that he poſſeſſes a human fetus of only five weeks old, which is the ſize of a common bee, and has all the features of the face, every finger, and every toe, complete; and in which the organs of generation are diſtinctly ſeen. P. 76. In another fetus, whoſe head was not larger than a pea, the whole of the baſis of the ſkull with all its depreſſions,

depreſſions, apertures, and proceſſes, were marked in the moſt ſharp and diſtinct manner, though without any oſſification. Ib.

5. In ſome caſes by the nutriment originally depoſited by the mother the filament acquires parts not exactly ſimilar to thoſe of the father, as in the production of mules and mulattoes. In other caſes, the deficiency of this original nutriment cauſes deficiencies of the extreme parts of the fetus, which are laſt formed, as the fingers, toes, lips. In other caſes, a duplicature of limbs are cauſed by the ſuperabundance of this original nutritive fluid, as in the double yolks of eggs, and the chickens from them with four legs and four wings. But the production of other monſters, as thoſe with two heads, or with parts placed in wrong ſituations, ſeems to ariſe from the imagination of the father being in ſome manner imitated by the extreme veſſels of the ſeminal glands; as the colours of the ſpots on eggs, and the change of the colour of the hair and feathers of animals by domeſtication, may be cauſed in the ſame manner by the imagination of the mother.

6. The living filament is a part of the father, and has therefore certain propenſities, or appetencies, which belong to him; which may have been gradually acquired during a million of generations, even from the infancy of the habitable earth; and which now poſſeſſes ſuch properties, as would render, by the appoſition of nutritious particles, the new fetus exactly ſimilar to the father; as occurs in the buds and bulbs of vegetables, and in the polypus, and tænia or tape-worm. But as the firſt nutriment is ſupplied by the mother, and therefore reſembles ſuch nutritive particles, as have been uſed for her own nutriment or growth, the progeny takes in part of the likeneſs of the mother.

Other ſimilarity of the excitability, or of the form of the male parent, ſuch as the broad or narrow ſhoulders,

ſhoulders, or ſuch as conſtitute certain hereditary diſeaſes, as ſcrophula, epilepſy, inſanity, have their origin produced in one or perhaps two generations; as in the progeny of thoſe who drink much vinous ſpirits; and thoſe hereditary propenſities ceaſe again, as I have obſerved, if one or two ſober generations ſucceed; otherwiſe the family becomes extinct.

This living filament from the father is alſo liable to have its propenſities, or appetencies, altered at the time of its production by the imagination of the male parent; the extremities of the ſeminal glands imitating the motions of the organs of ſenſe; and thus the ſex of the embryon is produced; which may be thus made a male or a female by affecting the imagination of the father at the time of impregnation. See Sect. XXXIX. 6. 3. and 7.

7. After the fetus is thus completely formed together with its umbilical veſſels and placenta, it is now ſupplied with a different kind of food, as appears by the difference of conſiſtency of the different parts of the white of the egg, and of the liquor amnii, for it has now acquired organs for digeſtion or ſecretion, and for oxygenation, though they are as yet feeble; which can in ſome degree change, as well as ſelect, the nutritive particles, which are now preſented to it. But may yet be affected by the deficiency of the quantity of nutrition ſupplied by the mother, or by the degree of oxygenation ſupplied to its placenta by the maternal blood.

The augmentation of the complete fetus by additional particles of nutriment is not accompliſhed by diſtention only, but by appoſition to every part both external and internal; each of which acquires by animal appetencies the new addition of the particles which it wants. And hence the enlarged parts are kept ſimilar to their prototypes, and may be ſaid to be extended; but their extenſion muſt be conceived only as a neceſſary conſequence of the enlargement

enlargement of all their parts by appoſition of new particles.

Hence the new appoſition of parts is not produced by capillary attraction, becauſe the whole is extended; whereas capillary attraction would rather tend to bring the ſides of flexible tubes together, and not to diſtend them. Nor is it produced by chemical affinities, for then a ſolution of continuity would ſucceed, as when ſugar is diſſolved in water; but it is produced by an animal proceſs, which is the conſequence of irritation, or ſenſation; and which may be termed animal appetency.

This is further evinced from experiments, which have been inſtituted to ſhew, that a living muſcle of an animal body requires greater force to break it, than a ſimilar muſcle of a dead body. Which evinces, that beſides the attraction of coheſion, which all matter poſſeſſes, and beſides the chemical attractions of affinities, which hold many bodies together, there is an animal adheſion, which adds vigour to theſe common laws of the inanimate world.

8. At the nativity of the child it depoſits the placenta or gills, and by expanding its lungs acquires more plentiful oxygenation from the currents of air, which it muſt now continue perpetually to reſpire to the end of its life; as it now quits the liquid element, in which it was produced, and like the tadpole, when it changes into a frog, becomes an aerial animal.

9. As the habitable parts of the earth have been, and continue to be, perpetually increaſing by the production of ſea-ſhells and corallines, and by the recrements of other animals, and vegetables; ſo from the beginning of the exiſtence of this terraqueous globe, the animals, which inhabit it, have conſtantly improved, and are ſtill in a ſtate of progreſſive improvement.

This

This idea of the gradual generation of all things ſeems to have been as familiar to the ancient philoſophers as to the modern ones; and to have given riſe to the beautiful hieroglyphic figure of the πρωτογονον ωον, or firſt great egg, produced by NIGHT, that is, whoſe origin is involved in obſcurity, and animated by ερως, that is, by DIVINE LOVE; from whence proceeded all things which exiſt.

Concluſion.

VIII. 1. CAUSE AND EFFECT may be conſidered as the progreſſion, or ſucceſſive motions, of the parts of the great ſyſtem of Nature The ſtate of things at this moment is the effect of the ſtate of things, which exiſted in the preceding moment; and the cauſe of the ſtate of things, which ſhall exiſt in the next moment.

Theſe cauſes and effects may be more eaſily comprehended, if motion be conſidered as a change of the figure of a group of bodies, as propoſed in Sect. XIV. 2. 2. inaſmuch as our ideas of viſible or tangible objects are more diſtinct, than our abſtracted ideas of their motions. Now the change of the configuration of the ſyſtem of nature at this moment muſt be an effect of the preceding configuration, for a change of configuration cannot exiſt without a previous configuration; and the proximate cauſe of every effect muſt immediately precede that effect. For example, a moving ivory ball could not proceed onwards, unleſs it had previouſly began to proceed; or unleſs an impulſe had been previouſly given it; which previous motion or impulſe conſtitutes a part of the laſt ſituation of things.

As the effects produced in this moment of time become cauſes in the next, we may conſider the progreſſive motions of objects as a chain of cauſes only;

only; whose first link proceeded from the great Creator, and which have existed from the beginning of the created universe, and are perpetually proceeding.

2. These causes may be conveniently divided into two kinds, efficient and inert causes, according with the two kinds of entity supposed to exist in the natural world, which may be termed matter and spirit, as proposed in Sect. I. and further treated of in Sect. XIV. The efficient causes of motion, or new configuration, consist either of the principle of gravitation, which actuates the sun and planets; or of the principle of particular gravitation, as in electricity, magnetism, heat; or of the principle of chemical affinity, as in combustion, fermentation, combination; or of the principle of organic life, as in the contraction of vegetable and animal fibres. The inert causes of motion, or new configuration, consist of the parts of matter, which are introduced within the spheres of activity of the principles above described. Thus, when an apple falls on the ground, the principle of gravitation is the efficient cause, and the matter of the apple the inert cause. If a bar of iron be approximated to a magnet, it may be termed the inert cause of the motion, which brings these two bodies into contact; while the magnetic principle may be termed the efficient cause. In the same manner the fibres, which constitute the retina, may be called the inert cause of the motions of that organ in vision, while the sensorial power may be termed the efficient cause.

3. Another more common distribution of the perpetual chain of causes and effects, which constitute the motions, or changing configurations, of the natural world, is into active and passive. Thus, if a ball in motion impinges against another ball at rest, and communicates its motion to it, the former ball is said to act, and the latter to be acted upon. In this sense of the words a magnet is said to attract iron;

iron; and the prick of a ſpur to ſtimulate a horſe into exertion; ſo that in this view of the works of nature all things may be ſaid either ſimply to exiſt, or to exiſt as cauſes, or to exiſt as effects; that is, to exiſt either in an active or paſſive ſtate.

This diſtribution of objects, and their motions, or changes of poſition, has been found ſo convenient for the purpoſes of common life, that on this foundation reſts the whole conſtruction or theory of language. The names of the things themſelves are termed by grammarians Nouns, and their modes of exiſtence are termed Verbs The nouns are divided into ſubſtantives, which denote the principal things ſpoken of; and into adjectives, which denote ſome circumſtances, or leſs kinds of things, belonging to the former. The verbs are divided into three kinds, ſuch as denote the exiſtence of things ſimply, as, to be; or their exiſtence in an active ſtate, as, to eat; or their exiſtence in a paſſive ſtate, as, to be eaten. Whence it appears, that all languages conſiſt only of nouns and verbs, with their abbreviations for the greater expedition of communicating our thoughts; as explained in the ingenious work of Mr. Horne Tooke, who has unfolded by a ſingle flaſh of light the whole theory of language, which has ſo long lain buried beneath the learned lumber of the ſchools. Diverſions of Purley. Johnſon. London.

4. A third diviſion of cauſes has been into proximate and remote; theſe have been much ſpoken of by the writers on medical ſubjects, but without ſufficient preciſion. If to proximate and remote cauſes we add proximate and remote effects, we ſhall include four links of the perpetual chain of cauſation; which will be more convenient for the diſcuſſion of many philoſophical ſubjects.

Thus if a particle of chyle be applied to the mouth of a lacteal veſſel, it may be termed the remote cauſe of

of the motions of the fibres, which compoſe the mouth of that lacteal veſſel; the ſenſorial power is the proximate cauſe; the contraction of the fibres of the mouth of the veſſel is the proximate effect; and their embracing the particle of chyle is the remote effect; and theſe four links of cauſation conſtitute abſorption.

Thus when we attend to the riſing ſun, firſt the yellow rays of light ſtimulate the ſenſorial power reſiding in the extremities of the optic nerve, this is the remote cauſe. 2. The ſenſorial power is excited into a ſtate of activity, this is the proximate cauſe. 3. The fibrous extremities of the optic nerve are contracted, this is the proximate effect. 4. A pleaſurable or painful ſenſation is produced in conſequence of the contraction of theſe fibres of the optic nerve, this is the remote effect; and theſe four links of the chain of cauſation conſtitute the ſenſitive idea, or what is commonly termed the ſenſation of the riſing ſun.

5. Other cauſes have been announced by medical writers under the names of cauſa procatarctica, and cauſa proegumina, and cauſa ſine quâ non. All which are links more or leſs diſtant of the chain of remote cauſes.

To theſe muſt be added the final cauſe, ſo called by many authors, which means the motive, for the accompliſhment of which the preceding chain of cauſes was put into action. The idea of a final cauſe, therefore, includes that of a rational mind, which employs means to effect its purpoſes; thus the deſire of preſerving himſelf from the pain of cold, which he has frequently experienced, induces the ſavage to conſtruct his hut; the fixing ſtakes into the ground for walls, branches of trees for rafters, and turf for a cover, are a ſeries of ſucceſſive voluntary exertions; which are ſo many means to produce a certain effect. This effect of preſerving himſelf

himſelf from cold, is termed the final cauſe; the conſtruction of the hut is the remote effect; the action of the muſcular fibres of the man, is the proximate effect; the volition, or activity of deſire to preſerve himſelf from cold, is the proximate cauſe; and the pain of cold, which excited that deſire, is the remote cauſe.

6. This perpetual chain of cauſes and effects, whoſe firſt link is rivetted to the throne of God, divides itſelf into innumerable diverging branches, which, like the nerves ariſing from the brain, permeate the moſt minute and moſt remote extremities of the ſyſtem, diffuſing motion and ſenſation to the whole. As every cauſe is ſuperior in power to the effect, which it has produced, ſo our idea of the power of the Almighty Creator becomes more elevated and ſublime, as we trace the operations of nature from cauſe to cauſe, climbing up the links of theſe chains of being, till we aſcend to the Great Source of all things.

Hence the modern diſcoveries in chemiſtry and in geology, by having traced the cauſes of the combinations of bodies to remoter origins, as well as thoſe in aſtronomy, which dignify the preſent age, contribute to enlarge and amplify our ideas of the power of the Great Firſt Cauſe. And had thoſe ancient philoſophers, who contended that the world was formed from atoms, aſcribed their combinations to certain immutable properties received from the hand of the Creator, ſuch as general gravitation, chemical affinity, or animal appetency, inſtead of aſcribing them to blind chance; the doctrine of atoms, as conſtituting or compoſing the material world by the variety of their combinations, ſo far from leading the mind to atheiſm, would ſtrengthen the demonſtration of the exiſtence of a Deity, as the firſt cauſe of all things; becauſe the analogy reſulting from our perpetual experience of cauſe and

effect would have thus been exemplified through universal nature.

The heavens declare the glory of GOD, *and the firmament sheweth his handywork! One day telleth another, and one night certifieth another; they have neither speech nor language, yet their voice is gone forth into all lands, and their words into the ends of the world. Manifold are thy works,* O LORD! *in wisdom hast thou made them all.* Psal. xix. civ.

SECT.

SECT. XL.

On the Ocular Spectra of Light and Colours, by Dr. R. W. Darwin, of Shrewsbury. Reprinted by Permission, from the Philosophical Transactions, Vol. LXXVI. p. 313.

Spectra of four kinds. 1. *Activity of the retina in vision.* 2. *Spectra from defect of sensibility.* 3. *Spectra from excess of sensibility.* 4. *Of direct ocular Spectra.* 5. *Greater stimulus excites the retina into spasmodic action.* 6. *Of reverse ocular spectra.* 7. *Greater stimulus excites the retina into various successive spasmodic actions.* 8. *Into fixed spasmodic action.* 9. *Into temporary paralysis.* 10. *Miscellaneous remarks;* 1. *Direct and reverse spectra at the same time. A spectral halo. Rule to predetermine the colours of spectra.* 2. *Variation of spectra from extraneous light.* 3. *Variation of spectra in number, figure, and remission.* 4. *Circulation of the blood in the eye is visible.* 5. *A new way of magnifying objects. Conclusion.*

WHEN any one has long and attentively looked at a bright object, as at the setting sun, on closing his eyes, or removing them, an image, which resembles in form the object he was attending to, continues some time to be visible; this appearance in the eye we shall call the ocular spectrum of that object.

These ocular spectra are of four kinds: 1st, Such as are owing to a less sensibility of a defined part of the retina; or *spectra from defect of sensibility.* 2d, Such as are owing to a greater sensibility of a

defined part of the retina; or *ſpectra from exceſs of ſenſibility*. 3d, Such as reſemble their object in its colour as well as form; which may be termed *direct ocular ſpectra*. 4th, Such as are of a colour contrary to that of their object; which may be termed *reverſe ocular ſpectra*.

The laws of light have been moſt ſucceſsfully explained by the great Newton, and the perception of viſible objects has been ably inveſtigated by the ingenious Dr. Berkeley and M. Malebranche; but theſe minute phænomena of viſion have yet been thought reducible to no theory, though many philoſophers have employed a conſiderable degree of attention upon them: among theſe are Dr. Jurin, at the end of Dr. Smith's Optics; M. Æpinus, in the Nov. Com. Petropol. V. 10.; M. Beguelin, in the Berlin Memoires, V. II. 1771; M. D'Arcy, in the Hiſtoire de l'Acad. des Scienc. 1765; M. de la Hire; and laſtly, the celebrated M. de Buffon, in the Memoires de l'Acad. des Scien. who has termed them accidental colours, as if ſubjected to no eſtabliſhed laws, Ac. Par. 1743. M. p. 215.

I muſt here apprize the reader, that it is very difficult for different people to give the ſame names to various ſhades of colours; whence, in the following pages, ſomething muſt be allowed, if on repeating the experiments the colours here mentioned ſhould not accurately correſpond with his own names of them.

I. *Activity of the Retina in Viſion.*

From the ſubſequent experiments it appears, that the retina is in an active not in a paſſive ſtate during the exiſtence of theſe ocular ſpectra; and it is thence to be concluded, that all viſion is owing to the activity of this organ.

1. Place

1. Place a piece of red ſilk, about an inch in diameter, as in plate 1, at Sect. III. 1, on a ſheet of white paper, in a ſtrong light; look ſteadily upon it from about the diſtance of half a yard for a minute; then cloſing your eyelids cover them with your hands, and a green ſpectrum will be ſeen in your eyes, reſembling in form the piece of red ſilk: after ſome time, this ſpectrum will diſappear and ſhortly re-appear; and this alternately three or four times, if the experiment is well made, till at length it vaniſhes entirely.

2. Place on a ſheet of white paper a circular piece of blue ſilk, about four inches in diameter, in the ſunſhine; cover the center of this with a circular piece of yellow ſilk, about three inches in diameter; and the center of the yellow ſilk with a circle of pink ſilk, about two inches in diameter; and the center of the pink ſilk with a circle of green ſilk, about one inch in diameter; and the centre of this with a circle of indigo, about half an inch in diameter; make a ſmall ſpeck with ink in the very centre of the whole, as in plate 3, at Sect. III. 3. 6.; look ſteadily for a minute on this central ſpot, and then cloſing your eyes, and applying your hand at about an inch diſtance before them, ſo as to prevent too much or too little light from paſſing through the eyelids, you will ſee the moſt beautiful circles of colours that imagination can conceive, which are moſt reſembled by the colours occaſioned by pouring a drop or two of oil on a ſtill lake in a bright day; but theſe circular iriſes of colours are not only different from the colours of the ſilks above mentioned, but are at the ſame time perpetually changing as long as they exiſt.

3. When any one in the dark preſſes either corner of his eye with his finger, and turns his eye away from his finger, he will ſee a circle of colours like thoſe in a peacock's tail: and a ſudden flaſh of light

light is excited in the eye by a ſtroke on it. (Newton's Opt. Q. 16.)

4. When any one turns round rapidly on one foot, till he becomes dizzy, and falls upon the ground, the ſpectra of the ambient objects continue to preſent themſelves in rotation, or appear to librate, and he ſeems to behold them for ſome time ſtill in motion.

From all theſe experiments it appears, that the ſpectra in the eye are not owing to the mechanical impulſe of light impreſſed on the retina, nor to its chemical combination with that organ, nor to the abſorption and emiſſion of light, as is obſerved in many bodies; for in all theſe caſes the ſpectra muſt either remain uniformly, or gradually diminiſh; and neither their alternate preſence and evaneſcence as in the firſt experiment, nor the perpetual changes of their colours as in the ſecond, nor the flaſh of light or colours in the preſſed eye as in the third, nor the rotation or libration of the ſpectra as in the fourth, could exiſt.

It is not abſurd to conceive, that the retina may be ſtimulated into motion, as well as the red and white muſcles which form our limbs and veſſels; ſince it conſiſts of fibres, like thoſe, intermixed with its medullary ſubſtance. To evince this ſtructure, the retina of an ox's eye was ſuſpended in a glaſs of warm water, and forcibly torn in a few places; the edges of theſe parts appeared jagged and hairy, and did not contract, and become ſmooth like ſimple mucus, when it is diſtended till it breaks; which ſhews that it conſiſts of fibres; and that its fibrous conſtruction became ſtill more diſtinct to the ſight, by adding ſome cauſtic alkali to the water, as the adhering mucus was firſt eroded, and the hair-like fibres remained floating in the veſſel. Nor does the degree of tranſparency of the retina invalidate the evidence of its fibrous ſtructure, ſince Leeuwenhoek has

has ſhewn that the cryſtalline humour itſelf conſiſts of fibres. (Arcana Naturæ, V. 1. p. 70.)

Hence it appears, that as the muſcles have larger fibres intermixed with a larger quantity of nervous medulla, the organ of viſion has a greater quantity of nervous medulla intermixed with ſmaller fibres; and it is probable that the locomotive muſcles, as well as the vaſcular ones, of microſcopic animals have much greater tenuity than theſe of the retina.

And beſides the ſimilar laws, which will be ſhewn in this paper to govern alike the actions of the retina and of the muſcles, there are many other analogies which exiſt between them. They are both originally excited into action by irritations, both act nearly in the ſame quantity of time, are alike ſtrengthened or fatigued by exertion, are alike painful if excited into action when they are in an inflamed ſtate, are alike liable to paralyſis, and to the torpor of old age.

II. Of spectra from defect of sensibility.

The retina is not ſo eaſily excited into action by leſs irritation after having been lately ſubjected to greater.

1. When any one paſſes from the bright daylight into a darkened room, the iriſes of his eyes expand themſelves to their utmoſt extent in a few ſeconds of time; but it is very long before the optic nerve, after having been ſtimulated by the greater light of the day, becomes ſenſible of the leſs degree of it in the room; and, if the room is not too obſcure, the iriſes will again contract themſelves in ſome degree, as the ſenſibility of the retina returns.

2. Place about half an inch ſquare of white paper on a black hat, and looking ſteadily on the center of it for a minute, remove your eyes to a ſheet of white

white paper; and after a ſecond or two a dark ſquare will be ſeen on the white paper, which will continue ſome time. A ſimilar dark ſquare will be ſeen in the cloſed eye, if light be admitted through the eyelids.

So after looking at any luminous object of a ſmall ſize, as at the ſun, for a ſhort time, ſo as not much to fatigue the eyes, this part of the retina becomes leſs ſenſible to ſmaller quantities of light; hence, when the eyes are turned on other leſs luminous parts of the ſky, a dark ſpot is ſeen reſembling the ſhape of the ſun, or other luminous object which we laſt beheld. This is the ſource of one kind of the dark-coloured *muſcæ volitantes*. If this dark ſpot lies above the center of the eye, we turn our eyes that way, expecting to bring it into the center of the eye, that we may view it more diſtinctly; and in this caſe the dark ſpectrum ſeems to move upwards. If the dark ſpectrum is found beneath the centre of the eye, we purſue it from the ſame motive, and it ſeems to move downwards. This has given riſe to various conjectures of ſomething floating in the aqueous humours of the eyes; but whoever, in attending to theſe ſpots, keeps his eyes unmoved by looking ſteadily at the corner of a cloud, at the ſame time that he obſerves the dark ſpectra, will be thoroughly convinced, that they have no motion but what is given to them by the movement of our eyes in purſuit of them. Sometimes the form of the ſpectrum, when it has been received from a circular luminous body, will become oblong; and ſometimes it will be divided into two circular ſpectra, which is not owing to our changing the angle made by the two optic axiſes, according to the diſtance of the clouds or other bodies to which the ſpectrum is ſuppoſed to be contiguous, but to other cauſes mentioned in No. X. 3.

X. 3. of this ſection. The apparent ſize of it will alſo be variable according to its ſuppoſed diſtance.

As theſe ſpectra are more eaſily obſervable when our eyes are a little weakened by fatigue, it has frequently happened, that people of delicate conſtitutions have been much alarmed at them, fearing a beginning decay of their ſight, and have thence fallen into the hands of ignorant oculiſts; but I believe they never are a prelude to any other diſeaſe of the eye, and that it is from habit alone, and our want of attention to them, that we do not ſee them on all objects every hour of our lives. But as the nerves of very weak people loſe their ſenſibility, in the ſame manner as their muſcles loſe their activity, by a ſmall time of exertion, it frequently happens, that ſick people in the extreme debility of fevers are perpetually employed in picking ſomething from the bed-clothes, occaſioned by their miſtaking the appearance of theſe *muſcæ volitantes* in their eyes. Benvenuto Celini, an Italian artiſt, a man of ſtrong abilities, relates, that having paſſed the whole night on a diſtant mountain with ſome companions and a conjurer, and performed many ceremonies to raiſe the devil, on their return in the morning to Rome, and looking up when the ſun began to riſe, they ſaw numerous devils run on the tops of the houſes, as they paſſed along; ſo much were the ſpectra of their weakened eyes magnified by fear, and made ſubſervient to the purpoſes of fraud or ſuperſtition. (Life of Ben. Celini.)

3. Place a ſquare inch of white paper on a large piece of ſtraw-coloured ſilk; look ſteadily ſome time on the white paper, and then move the centre of your eyes on the ſilk, and a ſpectrum of the form of the paper will appear on the ſilk, of a deeper yellow than the other part of it: for the central part of the retina, having been ſome time expoſed to the ſtimulus of a greater quantity of white light,

is

is become leſs ſenſible to a ſmaller quantity of it, and therefore ſees only the yellow rays in that part of the ſtraw-coloured ſilk.

Facts ſimilar to theſe are obſervable in other parts of our ſyſtem: thus, if one hand be made warm, and the other expoſed to the cold, and then both of them immerſed in ſubtepid water, the water is perceived warm to one hand, and cold to the other; and we are not able to hear weak ſounds for ſome time after we have been expoſed to loud ones; and we feel a chilline ſs on coming into an atmoſphere of temperate warmth, after having been ſome time confined in a very warm room: and hence the ſtomach, and other organs of digeſtion, of thoſe who have been habituated to the greater ſtimulus of ſpirituous liquor, are not excited into their due action by the leſs ſtimulus of common food alone; of which the immediate conſequence is indigeſtion and hypochondriaciſm.

III. Of spectra from excess of sensibility.

The retina is more eaſily excited into action by greater irritation after having been lately ſubjected to leſs.

1. If the eyes are cloſed, and covered perfectly with a hat, for a minute or two, in a bright day; on removing the hat, a red or crimſon light is ſeen through the eyelids. In this experiment the retina, after being ſome time kept in the dark, becomes ſo ſenſible to a ſmall quantity of light, as to perceive diſtinctly the greater quantity of red rays than of others which paſs through the eyelids. A ſimilar coloured light is ſeen to paſs through the edges of the fingers, when the open hand is oppoſed to the flame of a candle.

2. If

2. If you look for ſome minutes ſteadily on a window in the beginning of the evening twilight, or in a dark day, and then move your eyes a little, ſo that thoſe parts of the retina, on which the dark frame-work of the window was delineated, may now fall on the glaſs part of it, many luminous lines, repreſenting the frame-work, will appear to lie acroſs the glaſs panes: for thoſe parts of the retina, which were before leaſt ſtimulated by the dark frame-work, are now more ſenſible to light than the other parts of the retina which were expoſed to the more luminous parts of the window.

3. Make with ink on white paper a very black ſpot, about half an inch in diameter, with a tail about an inch in length, ſo as to repreſent a tadpole, as in plate 2, at Sect. III. 8. 3.; look ſteadily for a minute on this ſpot, and, on moving the eye a little, the figure of the tadpole will be ſeen on the white part of the paper, which figure of the tadpole will appear whiter or more luminous than the other parts of the white paper; for the part of the retina on which the tadpole was delineated, is now more ſenſible to light than the other parts of it, which were expoſed to the white paper. This experiment is mentioned by Dr. Irwin, but is not by him aſcribed to the true cauſe, namely, the greater ſenſibility of that part of the retina which has been expoſed to the black ſpot, than of the other parts which had received the white field of paper, which is put beyond a doubt by the next experiment.

4. On cloſing the eyes after viewing the black ſpot on the white paper, as in the foregoing experiment, a red ſpot is ſeen of the form of the black ſpot: for that part of the retina, on which the black ſpot was delineated, being now more ſenſible to light than the other parts of it, which were more expoſed to the white paper, is capable of perceiving the red rays which penetrate the eyelids. If this

this experiment be made by the light of a tallow candle, the ſpot will be yellow inſtead of red; for tallow candles abound much with yellow light, which paſſes in greater quantity and force through the eyelids than blue light; hence the difficulty of diſtinguiſhing blue and green by this kind of candle light. The colour of the ſpectrum may poſſibly vary in the daylight, according to the different colour of the meridian or the morning or evening light.

M. Beguelin, in the Berlin Memoires, V. II. 1771, obſerves, that, when he held a book, ſo that the ſun ſhone upon his half-cloſed eyelids, the black letters, which he had long inſpected, became red, which muſt have been thus occaſioned. Thoſe parts of the retina which had received for ſome time the black letters, were ſo much more ſenſible than thoſe parts which had been oppoſed to the white paper, that to the former the red light, which paſſed through the eyelids, was perceptible. There is a ſimilar ſtory told, I think, in M. de Voltaire's Hiſtorical Works, of a Duke of Tuſcany, who was playing at dice with the general of a foreign army, and, believing he ſaw bloody ſpots upon the dice, portended dreadful events, and retired in confuſion. The obſerver, after looking for a minute on the black ſpots of a die, and careleſsly cloſing his eyes, on a bright day, would ſee the image of a die with red ſpots upon it, as above explained.

5. On emerging from a dark cavern, where we have long continued, the light of a bright day becomes intolerable to the eye for a conſiderable time, owing to the exceſs of ſenſibility exiſting in the eye, after having been long expoſed to little or no ſtimulus. This occaſions us immediately to contract the iris to its ſmalleſt aperture, which becomes again gradually dilated, as the retina becomes accuſtomed to the greater ſtimulus of the daylight.

The

The twinkling of a bright ſtar, or of a diſtant candle in the night, is perhaps owing to the ſame cauſe. While we continue to look upon theſe luminous objects, their central parts gradually appear paler, owing to the decreaſing ſenſibility of the part of the retina expoſed to their light; whilſt, at the ſame time, by the unſteadineſs of the eye, the edges of them are perpetually falling on parts of the retina that were juſt before expoſed to the darkneſs of the night, and therefore tenfold more ſenſible to light than the part on which the ſtar or candle had been for ſome time delineated. This pains the eye in a ſimilar manner as when we come ſuddenly from a dark room into bright day-light, and gives the appearance of bright ſcintillations. Hence the ſtars twinkle moſt when the night is darkeſt, and do not twinkle through teleſcopes, as obſerved by Muſſchenbroeck; and it will afterwards be ſeen why this twinkling is ſometimes of different colours when the object is very bright, as Mr. Melvill obſerved in looking at Sirius. For the opinions of others on this ſubject, ſee Dr. Prieſtley's valuable Hiſtory of Light and Colours, p. 494.

Many facts obſervable in the animal ſyſtem are ſimilar to theſe; as the hot glow occaſioned by the uſual warmth of the air, or our clothes, on coming out of a cold bath; the pain of the fingers on approaching the fire after having handled ſnow; and the inflamed heels from walking in ſnow. Hence thoſe who have been expoſed to much cold have died on being brought to a fire, or their limbs have become ſo much inflamed as to mortify. Hence much food or wine given ſuddenly to thoſe who have almoſt periſhed by hunger has deſtroyed them; for all the organs of the famiſhed body are now become ſo much more irritable to the ſtimulus of food and wine, which they have long been deprived of, that

inflammation

inflammation is excited, which terminates in gangrene or fever.

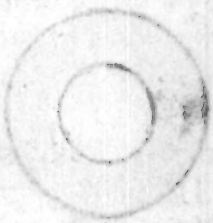
IV. Of direct ocular spectra.

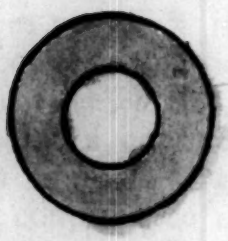
A quantity of ſtimulus ſomewhat greater than natural excites the retina into ſpaſmodic action, which ceaſes in a few ſeconds.

A certain duration and energy of the ſtimulus of light and colours excites the perfect action of the retina in viſion; for very quick motions are imperceptible to us, as well as very ſlow ones, as the whirling of a top, or the ſhadow on a ſun-dial. So perfect darkneſs does not affect the eye at all; and exceſs of light produces pain, not viſion.

1. When a fire-coal is whirled round in the dark, a lucid circle remains a conſiderable time in the eye; and that with ſo much vivacity of light, that it is miſtaken for a continuance of the irritation of the object. In the ſame manner, when a fiery meteor ſhoots acroſs the night, it appears to leave a long lucid train behind it, part of which, and perhaps ſometimes the whole, is owing to the continuance of the action of the retina after having been thus vividly excited. This is beautifully illuſtrated by the following experiment: fix a paper ſail, three or four inches in diameter, and made like that of a ſmoke jack, in a tube of paſteboard; on looking through the tube at a diſtant proſpect, ſome disjointed parts of it will be ſeen through the narrow intervals between the ſails; but as the fly begins to revolve, theſe intervals appear larger; and when it revolves quicker, the whole proſpect is ſeen quite as diſtinct as if nothing intervened, though leſs luminous.

2. Look





2. Look through a dark tube, about half a yard long, at the area of a yellow circle of half an inch diameter, lying upon a blue area of double that diameter, for half a minute; and on closing your eyes the colours of the spectrum will appear similar to the two areas, as in fig. 3.; but if the eye is kept too long upon them, the colours of the spectrum will be the reverse of those upon the paper, that is, the internal circle will become blue, and the external area yellow; hence some attention is required in making this experiment.

3. Place the bright flame of a spermaceti candle before a black object in the night; look steadily at it for a short time, till it is observed to become somewhat paler; and on closing the eyes, and covering them carefully, but not so as to compress them, the image of the blazing candle will continue distinctly to be visible.

4. Look steadily, for a short time, at a window in a black day, as in Exp. 2. Sect. III. and then closing your eyes, and covering them with your hands, an exact delineation of the window remains for some time visible in the eye. This experiment requires a little practice to make it succeed well; since, if the eyes are fatigued by looking too long on the window, or the day be too bright, the luminous parts of the window will appear dark in the spectrum, and the dark parts of the frame-work will appear luminous, as in Exp. 2. Sect. III. And it is even difficult for many, who first try this experiment, to perceive the spectrum at all; for any hurry of mind, or even too great attention to the spectrum itself, will disappoint them, till they have had a little experience in attending to such small sensations.

The spectra described in this section, termed direct ocular spectra, are produced without much fatigue of the eye; the irritation of the luminous object being soon withdrawn, or its quantity of light being

not so great as to produce any degree of uneasiness in the organ of vision; which distinguishes them from the next class of ocular spectra, which are the consequence of fatigue. These direct spectra are best observed in such circumstances that no light, but what comes from the object, can fall upon the eye; as in looking through a tube, of half a yard long, and an inch wide, at a yellow paper on the side of a room, the direct spectrum was easily produced on closing the eye without taking it from the tube; but if the lateral light is admitted through the eyelids, or by throwing the spectrum on white paper, it becomes a reverse spectrum, as will be explained below.

The other senses also retain for a time the impressions that have been made upon them, or the actions they have been excited into. So if a hard body is pressed upon the palm of the hand, as is practised in tricks of legerdemain, it is not easy to distinguish for a few seconds whether it remains or is removed; and tastes continue long to exist vividly in the mouth, as the smoke of tobacco, or the taste of gentian, after the sapid material is withdrawn.

V. *A quantity of stimulus somewhat greater than the last mentioned excites the retina into spasmodic action, which ceases and recurs alternately.*

1. On looking for a time on the setting sun, so as not greatly to fatigue the sight, a yellow spectrum is seen when the eyes are closed and covered, which continues for a time, and then disappears and recurs repeatedly before it entirely vanishes. This yellow spectrum of the sun when the eyelids are opened becomes blue; and if it is made to fall on the green grass, or on other coloured objects, it

varies its own colour by an intermixture of theirs, as will be explained in another place.

2. Place a lighted ſpermaceti candle in the night about one foot from your eye, and look ſteadily on the centre of the flame, till your eye becomes much more fatigued than in Sect. IV. Exp. 3.; and on cloſing your eyes a reddiſh ſpectrum will be perceived, which will ceaſe and return alternately.

The action of vomiting in like manner ceaſes, and is renewed by intervals, although the emetic drug is thrown up with the firſt effort: ſo after-pains continue ſome time after parturition; and the alternate pulſations of the heart of a viper are renewed for ſome time after it is cleared from its blood.

VI. Of reverse ocular spectra.

The retina, after having been excited into action by a ſtimulus ſomewhat greater than the laſt mentioned, falls into oppoſite ſpaſmodic action.

The actions of every part of animal bodies may be advantageouſly compared with each other. This ſtrict analogy contributes much to the inveſtigation of truth; while thoſe looſer analogies, which compare the phenomena of animal life with thoſe of chemiſtry or mechanics, only ſerve to miſlead our inquiries.

When any of our larger muſcles have been in long or in violent action, and their antagoniſts have been at the ſame time extended, as ſoon as the action of the former ceaſes, the limb is ſtretched the contrary way for our eaſe, and a pandiculation or yawning takes place.

By the following obſervation it appears, that a ſimilar circumſtance obtains in the organ of viſion;

after it has been fatigued by one kind of action, it ſpontaneouſly falls into the oppoſite kind.

1. Place a piece of coloured ſilk, about an inch in diameter, on a ſheet of white paper, about half a yard from your eyes; look ſteadily upon it for a minute; then remove your eyes upon another part of the white paper, and a ſpectrum will be ſeen of the form of the ſilk thus inſpected, but of a colour oppoſite to it. A ſpectrum nearly ſimilar will appear if the eyes are cloſed, and the eyelids ſhaded by approaching the hand near them, ſo as to permit ſome, but to prevent too much light falling on them.

Red ſilk produced a green ſpectrum.
Green produced a red one.
Orange produced blue.
Blue produced orange.
Yellow produced violet.
Violet produced yellow.

That in theſe experiments the colours of the ſpectra are the reverſe of the colours which occaſioned them, may be ſeen by examining the third figure in Sir Iſaac Newton's Optics, L. II. p. 1, where thoſe thin laminæ of air, which reflected yellow, tranſmitted violet; thoſe which reflected red, tranſmitted a blue green; and ſo of the reſt, agreeing with the experiments above related.

2. Theſe reverſe ſpectra are ſimilar to a colour, formed by a combination of all the primary colours except that with which the eye has been fatigued in making the experiment: thus the reverſe ſpectrum of red muſt be ſuch a green as would be produced by a combination of all the other priſmatic colours. To evince this fact the following ſatisfactory experiment was made. The priſmatic colours were laid on a circular paſteboard wheel, about four inches in diameter, in the proportions deſcribed in Dr. Prieſtley's Hiſtory of Light and Colours, pl. 12. fig. 83

excep

except that the red compartment was entirely left out, and the others proportionably extended ſo as to complete the circle. Then, as the orange is a mixture of red and yellow, and as the violet is a mixture of red and indigo, it became neceſſary to put yellow on the wheel inſtead of orange, and indigo inſtead of violet, that the experiment might more exactly quadrate with the theory it was deſigned to eſtabliſh or confute; becauſe in gaining a green ſpectrum from a red object, the eye is ſuppoſed to have become inſenſible to red light. This wheel, by means of an axis, was made to whirl like a top; and on its being put in motion, a green colour was produced, correſponding with great exactneſs to the reverſe ſpectrum of red.

3. In contemplating any one of theſe reverſe ſpectra in the cloſed and covered eye, it diſappears and re-appears ſeveral times ſucceſſively, till at length it entirely vaniſhes, like the direct ſpectra in Sect. V.; but with this additional circumſtance, that when the ſpectrum becomes faint or evaneſcent, it is inſtantly revived by removing the hand from before the eyelids, ſo as to admit more light: becauſe then not only the fatigued part of the retina is inclined ſpontaneouſly to fall into motions of a contrary direction, but being ſtill ſenſible to all other rays of light, except that with which it was lately fatigued, is by theſe rays at the ſame time ſtimulated into thoſe motions which form the reverſe ſpectrum.

From theſe experiments there is reaſon to conclude, that the fatigued part of the retina throws itſelf into a contrary mode of action, like oſcitation or pandiculation, as ſoon as the ſtimulus which has fatigued it is withdrawn; and that it ſtill remains ſenſible, that is, liable to be excited into action by any other colours at the ſame time, except the colour with which it has been fatigued.

VII. *The*

VII. *The retina after having been excited into action by a ſtimulus ſomewhat greater than the laſt mentioned falls into various ſucceſſive ſpaſmodic actions.*

1. On looking at the meridian ſun as long as the eyes can well bear its brightneſs, the diſk firſt becomes pale, with a luminous creſcent, which ſeems to librate from one edge of it to the other, owing to the unſteadineſs of the eye; then the whole phaſis of the ſun becomes blue, ſurrounded with a white halo; and on cloſing the eyes, and covering them with the hands, a yellow ſpectrum is ſeen, which in a little time changes into a blue one.

M. de la Hire obſerved, after looking at the bright ſun, that the impreſſion in his eye firſt aſſumed a yellow appearance, and then green, and then blue; and wiſhes to aſcribe theſe appearances to ſome affection of the nerves. (Porterfield on the eye, Vol. I. p. 343.)

2. After looking ſteadily on about an inch ſquare of pink ſilk, placed on white paper, in a bright ſunſhine, at the diſtance of a foot from my eyes, and cloſing and covering my eyelids, the ſpectrum of the ſilk was at firſt a dark green, and the ſpectrum of the white paper became of a pink. The ſpectra then both diſappeared; and then the internal ſpectrum was blue; and then, after a ſecond diſappearance, became yellow, and laſtly pink, whilſt the ſpectrum of the field varied into red and green.

Theſe ſucceſſions of different coloured ſpectra were not exactly the ſame in the different experiments, though obſerved, as near as could be, with the ſame quantity of light, and other ſimilar circumſtances; owing, I ſuppoſe, to trying too many experiments at a time; ſo that the eye was not quite free from the ſpectra of the colours which were previouſly attended to.

The

The alternate exertions of the retina in the preceding ſection reſembled the oſcitation or pandiculation of the muſcles, as they were performed in directions contrary to each other, and were the conſequence of fatigue rather than of pain. And in this they differ from the ſucceſſive diſſimilar exertions of the retina, mentioned in this ſection, which reſemble in miniature the more violent agitations of the limbs in convulſive diſeaſes, as epilepſy, chorea S. Viti, and opiſthotonos; all which diſeaſes are perhaps, at firſt, the conſequence of pain, and have their periods afterwards eſtabliſhed by habit.

VIII. *The retina, after having been excited into action by a ſtimulus ſomewhat greater than the laſt mentioned, falls into a fixed ſpaſmodic action, which continues for ſome days.*

1. AFTER having looked long at the meridian ſun, in making ſome of the preceding experiments, till the diſks faded into a pale blue, I frequently obſerved a bright blue ſpectrum of the ſun on other objects all the next and the ſucceeding day, which conſtantly occurred when I attended to it, and frequently when I did not previouſly attend to it. When I cloſed and covered my eyes, this appeared of a dull yellow; and at other times mixed with the colours of other objects on which it was thrown. It may be imagined, that this part of the retina was become inſenſible to white light, and thence a bluiſh ſpectrum became viſible on all luminous objects; but as a yellowiſh ſpectrum was alſo ſeen in the cloſed and covered eye, there can remain no doubt of this being the ſpectrum of the ſun. A ſimilar appearance was obſerved by M. Æpinus, which he acknowledges he could give no account of. (Nov. Com. Petrop. V. 10. p. 2. and 6.)

The

The locked jaw, and ſome cataleptic ſpaſms, are reſembled by this phenomenon; and from hence we may learn the danger to the eye by inſpecting very luminous objects too long a time.

IX. *A quantity of ſtimulus greater than the preceding induces a temporary paralyſis of the organ of viſion.*

1. Place a circular piece of bright red ſilk, about half an inch in diameter, on the middle of a ſheet of white paper; lay them on the floor in a bright ſunſhine, and fixing your eyes ſteadily on the center of the red circle, for three or four minutes, at the diſtance of four or ſix feet from the object, the red ſilk will gradually become paler, and finally ceaſe to appear red at all.

2. Similar to theſe are many other animal facts; as purges, opiates, and even poiſons, and contagious matter, ceaſe to ſtimulate our ſyſtem, after we have been habituated to their uſe. So ſome people ſleep undiſturbed by a clock, or even by a forge hammer in their neighbourhood: and not only continued irritations, but violent exertions of any kind, are ſucceeded by temporary paralyſis. The arm drops down after violent action, and continues for a time uſeleſs; and it is probable, that thoſe who have periſhed ſuddenly in ſwimming, or in ſcating on the ice, have owed their deaths to the paralyſis, or extreme fatigue, which ſucceeds every violent and continued exertion.

X. Miscellaneous Remarks.

There were ſome circumſtances occurred in making theſe experiments, which were liable to alter the reſults of them, and which I ſhall here mention for

for the aſſiſtance of others, who may wiſh to repeat them.

1. *Of direct and inverſe ſpectra exiſting at the ſame time; of reciprocal direct ſpectra; of a combination of direct and inverſe ſpectra; of a ſpectral halo; rules to pre-determine the colours of ſpectra.*

a. When an area, about ſix inches ſquare, of bright pink Indian paper, had been viewed on an area, about a foot ſquare, of white writing paper, the internal ſpectrum in the cloſed eye was green, being the reverſe ſpectrum of the pink paper; and the external ſpectrum was pink, being the direct ſpectrum of the pink paper. The ſame circumſtance happened when the internal area was white, and external one pink; that is, the internal ſpectrum was pink, and the external one green. All the ſame appearances occurred when the pink paper was laid on a black hat.

b. When ſix inches ſquare of deep violet poliſhed paper was viewed on a foot ſquare of white writing paper, the internal ſpectrum was yellow, being the reverſe ſpectrum of the violet paper, and the external one was violet, being the direct ſpectrum of the violet paper.

c. When ſix inches ſquare of pink paper was viewed on a foot ſquare of blue paper, the internal ſpectrum was blue, and the external ſpectrum was pink; that is, the internal one was the direct ſpectrum of the external object, and the external one was the direct ſpectrum of the internal object, inſtead of their being each the reverſe ſpectrum of the objects they belonged to.

d. When ſix inches ſquare of blue paper were viewed on a foot ſquare of yellow paper, the interior ſpectrum became a brilliant yellow, and the exterior one a brilliant blue. The vivacity of the

ſpectra

ſpectra was owing to their being excited both by the ſtimulus of the interior and exterior objects; ſo that the interior yellow ſpectrum was both the reverſe ſpectrum of the blue paper, and the direct one of the yellow paper; and the exterior blue ſpectrum was both the reverſe ſpectrum of the yellow paper, and the direct one of the blue paper.

e. When the internal area was only a ſquare half-inch of red paper, laid on a ſquare foot of dark violet paper, the internal ſpectrum was green, with a reddiſh-blue halo. When the red internal paper was two inches ſquare, the internal ſpectrum was a deeper green, and the external one redder. When the internal paper was ſix inches ſquare, the ſpectrum of it became blue, and the ſpectrum of the external paper was red.

f. When a ſquare half-inch of blue paper was laid on a ſix-inch ſquare of yellow paper, the ſpectrum of the central paper in the cloſed eye was yellow, incircled with a blue halo. On looking long on the meridian ſun, the diſk fades into a pale blue ſurrounded with a whitiſh halo.

Theſe circumſtances, though they very much perplexed the experiments till they were inveſtigated, admit of a ſatisfactory explanation; for while the rays from the bright internal object in exp. *a.* fall with their full force on the center of the retina, and, by fatiguing that part of it, induce the reverſe ſpectrum, many ſcattered rays, from the ſame internal pink paper, fall on the more external parts of the retina, but not in ſuch quantity as to occaſion much fatigue, and hence induce the direct ſpectrum of the pink colour in thoſe parts of the eye. The ſame reverſe and direct ſpectra occur from the violet paper in exp. *b.*: and in exp. *c.* the ſcattered rays from the central pink paper produce a direct ſpectrum of this colour on the external parts of the eye, while the ſcattered rays from the external blue paper produce a direct ſpectrum of that colour on the central

tral part of the eye, inſtead of theſe parts of the retina falling reciprocally into their reverſe ſpectra. In exp. *d.* the colours being the reverſe of each other, the ſcattered rays from the exterior object falling on the central parts of the eye, and there exciting their direct ſpectrum, at the ſame time that the retina was excited into a reverſe ſpectrum by the central object, and this direct and reverſe ſpectrum being of ſimilar colour, the ſuperior brilliancy of this ſpectrum was produced. In exp. *e.* the effect of various quantities of ſtimulus on the retina, from the different reſpective ſizes of the internal and external areas, induced a ſpectrum of the internal area in the center of the eye, combined of the reverſe ſpectrum of that internal area and the direct one of the external area, in various ſhades of colour, from a pale green to a deep blue, with ſimilar changes in the ſpectrum of the external area. For the ſame reaſons, when an internal bright object was ſmall, as in exp. *f.* inſtead of the whole of the ſpectrum of the external object being reverſe to the colour of the internal object, only a kind of halo, or radiation of colour, ſimilar to that of the internal object, was ſpread a little way on the external ſpectrum. For this internal blue area being ſo ſmall, the ſcattered rays from it extended but a little way on the image of the external area of yellow paper, and could therefore produce only a blue halo round the yellow ſpectrum in the center.

If any one ſhould ſuſpect that the ſcattered rays from the exterior coloured object do not intermix with the rays from the interior coloured object, and thus affect the central part of the eye, let him look through an opake tube, about two feet in length, and an inch in diameter, at a coloured wall of a room with one eye, and with the other eye naked; and he will find, that by ſhutting out the lateral light, the area of the wall ſeen through a tube appears as if illuminated by the ſunſhine, compared with

with the other parts of it; from whence ariſes the advantage of looking through a dark tube at diſtant paintings.

Hence we may ſafely deduce the following rules to determine before-hand the colours of all ſpectra. 1. The direct ſpectrum without any lateral light is an evaneſcent repreſentation of its object in the unfatigued eye. 2. With ſome lateral light it becomes of a colour combined of the direct ſpectrum of the central object, and of the circumjacent objects, in proportion to their reſpective quantity and brilliancy. 3. The reverſe ſpectrum without lateral light is a repreſentation in the fatigued eye of the form of its objects, with ſuch a colour as would be produced by all the primary colours, except that of the object. 4. With lateral light the colour is compounded of the reverſe ſpectrum of the central object, and the direct ſpectrum of the circumjacent objects, in proportion to their reſpective quantity and brilliancy.

2. *Variation and vivacity of the ſpectra occaſioned by extraneous light.*

The reverſe ſpectrum, as has been before explained, is ſimilar to a colour, formed by a combination of all the primary colours, except that with which the eye has been fatigued in making the experiment: ſo the reverſe ſpectrum of red is ſuch a green as would be produced by a combination of all the other priſmatic colours. Now it muſt be obſerved, that this reverſe ſpectrum of red is therefore the direct ſpectrum of a combination of all the other priſmatic colours, except the red; whence, on removing the eye from a piece of red ſilk to a ſheet of white paper, the green ſpectrum, which is perceived, may either be called the reverſe ſpectrum of the

the red ſilk, or the direct ſpectrum of all the rays from the white paper, except the red; for in truth it is both. Hence we ſee the reaſon why it is not eaſy to gain a direct ſpectrum of any coloured object in the day-time, where there is much lateral light, except of very bright objects, as of the ſetting ſun, or by looking through an opake tube; becauſe the lateral external light falling alſo on the central part of the retina, contributes to induce the reverſe ſpectrum, which is at the ſame time the direct ſpectrum of that lateral light, deducting only the colour of the central object which we have been viewing. And for the ſame reaſon, it is difficult to gain the reverſe ſpectrum, where there is no lateral light to contribute to its formation. Thus, in looking through an opake tube on a yellow wall, and cloſing my eye, without admitting any lateral light, the ſpectra were all at firſt yellow; but at length changed into blue. And on looking in the ſame manner on red paper, I did at length get a green ſpectrum; but they were all at firſt red ones: and the ſame after looking at a candle in the night.

The reverſe ſpectrum was formed with greater facility when the eye was thrown from the object on a ſheet of white paper, or when light was admitted through the cloſed eyelids; becauſe not only the fatigued part of the retina was inclined ſpontaneouſly to fall into motions of a contrary direction; but being ſtill ſenſible to all other rays of light except that with which it was lately fatigued, was by theſe rays ſtimulated at the ſame time into thoſe motions which form the reverſe ſpectrum. Hence, when the reverſe ſpectrum of any colour became faint, it was wonderfully revived by admitting more light through the eyelids, by removing the hand from before them: and hence, on covering the cloſed eyelids, the ſpectrum would often ceaſe for a time, till the retina became ſenſible to the ſtimulus of the ſmaller

ſmaller quantity of light, and then it recurred. Nor was the ſpectrum only changed into vivacity, or in degree, by this admiſſion of light through the eyelids; but it frequently happened, after having viewed bright objects, that the ſpectrum in the cloſed and covered eye was changed into a third ſpectrum, when light was admitted through the eyelids: which third ſpectrum was compoſed of ſuch colours as could paſs through the eyelids, except thoſe of the object. Thus, when an area of half an inch diameter of pink paper was viewed on a ſheet of white paper in the ſunſhine, the ſpectrum with cloſed and covered eyes was green; but on removing the hands from before the cloſed eyelids, the ſpectrum became yellow, and returned inſtantly again to green, as often as the hands were applied to cover the eyelids, or removed from them: for the retina being now inſenſible to red light, the yellow rays paſſing through the eyelids in greater quantity than the other colours, induced a yellow ſpectrum; whereas if the ſpectrum was thrown on white paper, with the eyes open, it became only a lighter green.

Though a certain quantity of light facilitates the formation of the reverſe ſpectrum, a greater quantity prevents its formation, as the more powerful ſtimulus excites even the fatigued parts of the eye into action; otherwiſe we ſhould ſee the ſpectrum of the laſt viewed object as often as we turn our eyes. Hence the reverſe ſpectra are beſt ſeen by gradually approaching the hand near the cloſed eyelids to a certain diſtance only, which muſt be varied with the brightneſs of the day, or the energy of the ſpectrum. Add to this, that all dark ſpectra, as black, blue, or green, if light be admitted through the eyelids, after they have been ſome time covered, give reddiſh ſpectra, for the reaſons given in Sect. III. Exp. 1.

From

From theſe circumſtances of the extraneous light coinciding with the ſpontaneous efforts of the fatigued retina to produce a reverſe ſpectrum, as was obſerved before, it is not eaſy to gain a direct ſpectrum, except of objects brighter than the ambient light; ſuch as a candle in the night, the ſetting ſun, or viewing a bright object through an opake tube; and then the reverſe ſpectrum is inſtantaneouſly produced by the admiſſion of ſome external light; and is as inſtantly converted again to the direct ſpectrum by the excluſion of it. Thus, on looking at the ſetting ſun, on cloſing the eyes, and covering them, a yellow ſpectrum is ſeen, which is the direct ſpectrum of the ſetting ſun; but on opening the eyes on the ſky, the yellow ſpectrum is immediately changed into a blue one, which is the reverſe ſpectrum of the yellow ſun, or the direct ſpectrum of the blue ſky, or a combination of both. And this is again transformed into a yellow one on cloſing the eyes, and ſo reciprocally, as quick as the motions of the opening and cloſing eyelids. Hence, when Mr. Melvill obſerved the ſcintillations of the ſtar Sirius to be ſometimes coloured, theſe were probably the direct ſpectrum of the blue ſky on the parts of the retina fatigued by the white light of the ſtar. (Eſſays Phyſical and Literary, p. 81. V. 2.)

When a direct ſpectrum is thrown on colours darker than itſelf, it mixes with them; as the yellow ſpectrum of the ſetting ſun, thrown on the green graſs, becomes a greener yellow. But when a direct ſpectrum is thrown on colours brighter than itſelf, it becomes inſtantly changed into the reverſe ſpectrum, which mixes with thoſe brighter colours. So the yellow ſpectrum of the ſetting ſun thrown on the luminous ſky becomes blue, and changes with the colour or brightneſs of the clouds on which it appears. But the reverſe ſpectrum mixes with every kind of colour on which it is thrown, whether

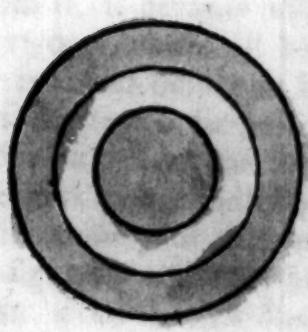
whether brighter than itſelf or not: thus the reverſe ſpectrum, obtained by viewing a piece of yellow ſilk, when thrown on white paper, was a lucid blue green; when thrown on black Turkey leather, becomes a deep violet. And the ſpectrum of blue ſilk, thrown on white paper, was a light yellow; on black ſilk was an obſcure orange; and the blue ſpectrum, obtained from orange-coloured ſilk, thrown on yellow, became a green.

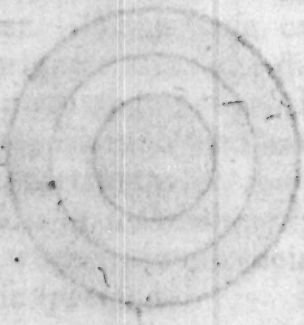
In theſe caſes the retina is thrown into activity or ſenſation by the ſtimulus of external colours, at the ſame time that it continues the activity or ſenſation which forms the ſpectra; in the ſame manner as the priſmatic colours, painted on a whirling top, are ſeen to mix together. When theſe colours of external objects are brighter than the direct ſpectrum which is thrown upon them, they change it into the reverſe ſpectrum, like the admiſſion of external light on a direct ſpectrum, as explained above. When they are darker than the direct ſpectrum, they mix with it, their weaker ſtimulus being inſufficient to induce the reverſe ſpectrum.

3. *Variation of ſpectra in reſpect to number, and figure, and remiſſion.*

When we look long and attentively at any object, the eye cannot always be kept entirely motionleſs; hence, on inſpecting a circular area of red ſilk placed on white paper, a lucid creſcent or edge is ſeen to librate on one ſide or other of the red circle: for the exterior parts of the retina ſometimes falling on the edge of the central ſilk, and ſometimes on the white paper, are leſs fatigued with red light than the central part of the retina, which is conſtantly expoſed to it; and therefore, when they fall on the edge of the red ſilk, they perceive

it





it more vividly. Afterwards, when the eye becomes fatigued, a green ſpectrum in the form of a creſcent is ſeen to librate on one ſide or other of the central circle, as by the unſteadineſs of the eye a part of the fatigued retina falls on the white paper; and as by the increaſing fatigue of the eye the central part of the ſilk appears paler, the edge on which the unfatigued part of the retina occaſionally falls will appear of a deeper red than the original ſilk, becauſe it is compared with the pale internal part of it. M. de Buffon in making this experiment obſerved, that the red edge of the ſilk was not only deeper coloured than the original ſilk; but, on his retreating a little from it, it became oblong, and at length divided into two, which muſt have been owing to his obſerving it either before or behind the point of interſection of the two optic axiſes. Thus, if a pen is held up before a diſtant candle, when we look intenſely at the pen, two candles are ſeen behind it; when we look intenſely at the candle, two pens are ſeen. If the ſight be unſteady at the time of beholding the ſun, even though one eye only be uſed, many images of the ſun will appear, or luminous lines, when the eye is cloſed. And as ſome parts of theſe will be more vivid than others, and ſome parts of them will be produced nearer the centre of the eye than others, theſe will diſappear ſooner than the others; and hence the number and ſhape of theſe ſpectra of the ſun will continually vary, as long as they exiſt. The cauſe of ſome being more vivid than others, is the unſteadineſs of the eye of the beholder, ſo that ſome parts of the retina have been longer expoſed to the ſunbeams. That ſome parts of a complicated ſpectrum fade and return before other parts of it, the following experiment evinces. Draw three concentric circles; the external one an inch and a half in diameter, the middle one an inch, and the internal one half an inch; co-

lour the external and internal areas blue, as in Fig. 4.; after having looked about a minute on the centre of theſe circles, in a bright light, the ſpectrum of the external area appears firſt in the cloſed eye, then the middle area, and laſtly the central one; and then the central one diſappears, and the others in inverted order. If concentric circles of more colours are added, it produces the beautiful ever changing ſpectrum in Sect. I. Exp. 2.

From hence it would ſeem, that the centre of the eye produces quicker remiſſions of ſpectra, owing perhaps to its greater ſenſibility; that is, to its more energetic exertions. Theſe remiſſions of ſpectra bear ſome analogy to the tremors of the hands, and palpitations of the heart, of weak people: and perhaps a criterion of the ſtrength of any muſcle or nerve may be taken from the time it can be continued in exertion.

4. *Variation of ſpectra in reſpect to brilliancy; the viſibility of the circulation of the blood in the eye.*

1. The meridian or evening light makes a difference in the colours of ſome ſpectra; for as the ſun deſcends, the red rays, which are leſs refrangible by the convex atmoſphere, abound in great quantity. Whence the ſpectrum of the light parts of a window at this time, or early in the morning, is red; and becomes blue either a little later or earlier; and white in the meridian day; and is alſo variable from the colour of the clouds or ſky which are oppoſed to the window.

2. All theſe experiments are liable to be confounded, if they are made too ſoon after each other, as the remaining ſpectrum will mix with the new ones. This is a very troubleſome circumſtance to painters, who are obliged to look long upon the ſame colou;

colour; and in particular to thoſe whoſe eyes, from natural debility, cannot long continue the ſame kind of exertion. For the ſame reaſon, in making theſe experiments, the reſult becomes much varied if the eyes, after viewing any object, are removed on other objects for but an inſtant of time, before we cloſe them to view the ſpectrum; for the light from the object, of which we had only a tranſient view, in the very time of cloſing our eyes acts as a ſtimulus on the fatigued retina; and for a time prevents the deſired ſpectrum from appearing, or mixes its own ſpectrum with it. Whence, after the eyelids are cloſed, either a dark field, or ſome unexpected colours, are beheld for a few ſeconds, before the deſired ſpectrum becomes diſtinctly viſible.

3. The length of time taken up in viewing an object, of which we are to obſerve the ſpectrum, makes a great difference in the appearance of the ſpectrum, not only in its vivacity, but in its colour; as the direct ſpectrum of the central object, or of the circumjacent ones, and alſo the reverſe ſpectra of both, with their various combinations, as well as the time of their duration in the eye, and of their remiſſions or alternations, depend upon the degree of fatigue the retina is ſubjected to. The Chevalier d'Arcy conſtructed a machine by which a coal of fire was whirled round in the dark, and found, that when a luminous body made a revolution in eight thirds of time, it preſented to the eye a complete circle of fire; from whence he concludes, that the impreſſion continues on the organ about the ſeventh part of a ſecond. (Mem. de l'Acad. des Sc. 1765.) This, however, is only to be conſidered as the ſhorteſt time of the duration of theſe direct ſpectra; ſince in the fatigued eye both the direct and reverſe ſpectra, with their intermiſſions, appear to take up many ſeconds of time, and ſeem very variable in proportion to the circumſtances of fatigue or energy.

4. It

4. It ſometimes happens, if the eyeballs have been rubbed hard with the fingers, that lucid ſparks are ſeen in quick motion amidſt the ſpectrum we are attending to. This is ſimilar to the flaſhes of fire from a ſtroke on the eye in fighting, and is reſembled by the warmth and glow, which appears upon the ſkin after friction, and is probably owing to an acceleration of the arterial blood into the veſſels emptied by the previous preſſure. By being accuſtomed to obſerve ſuch ſmall ſenſations in the eye, it is eaſy to ſee the circulation of the blood in this organ. I have attended to this frequently, when I have obſerved my eyes more than commonly ſenſible to other ſpectra. The circulation may be ſeen either in both eyes at a time, or only in one of them; for as a certain quantity of light is neceſſary to produce this curious phenomenon, if one hand be brought nearer the cloſed eyelids than the other, the circulation in that eye will for a time diſappear. For the eaſier viewing the circulation, it is ſometimes neceſſary to rub the eyes with a certain degree of force after they are cloſed, and to hold the breath rather longer than is agreeable, which, by accumulating more blood in the eye, facilitates the experiment; but in general it may be ſeen diſtinctly after having examined other ſpectra with your back to the light, till the eyes become weary; then having covered your cloſed eyelids for half a minute, till the ſpectrum is faded away which you were examining, turn your face to the light, and removing your hands from the eyelids, by and by again ſhade them a little, and the circulation becomes curiouſly diſtinct. The ſtreams of blood are however generally ſeen to unite, which ſhews it to be the venous circulation, owing, I ſuppoſe, to the greater opacity of the colour of the blood in theſe veſſels; for this venous circulation is alſo much more eaſily ſeen by the microſcope in the tail of a tadpole.

5. *Variation of ſpectra in reſpect to diſtinctneſs and ſize; with a new way of magnifying objects.*

1. It was before obſerved, that when the two colours viewed together were oppoſite to each other, as yellow and blue, red and green, &c. according to the table of reflections and tranſmiſſions of light in Sir Iſaac Newton's Optics, B. II. Fig. 3. the ſpectra of thoſe colours were of all others the moſt brilliant, and beſt defined; becauſe they were combined of the reverſe ſpectrum of one colour, and of the direct ſpectrum of the other. Hence, in books printed with ſmall types, or in the minute gradation of thermometers, or of clock-faces, which are to be ſeen at a diſtance, if the letters or figures are coloured with orange, and the ground with indigo; or the letters with red, and the ground with green; or any other lucid colour is uſed for the letters, the ſpectrum of which is ſimilar to the colour of the ground, ſuch letters will be ſeen much more diſtinctly, and with leſs confuſion, than in black or white: for as the ſpectrum of the letter is the ſame colour with the ground on which they are ſeen, the unſteadineſs of the eye in long attending to them will not produce coloured lines by the edges of the letters, which is the principal cauſe of their confuſion. The beauty of colours lying in vicinity to each other, whoſe ſpectra are thus reciprocally ſimilar to each colour, is owing to this greater eaſe that the eye experiences in beholding them diſtinctly; and it is probable, in the organ of hearing, a ſimilar circumſtance may conſtitute the pleaſure of melody. Sir Iſaac Newton obſerves, that gold and indigo were agreeable when viewed together; and thinks there may be ſome analogy between the ſenſations of light and ſound. (Optics, Qu. 14.)

In

In viewing the ſpectra of bright objects, as of an area of red ſilk of half an inch diameter on white paper, it is eaſy to magnify it to tenfold its ſize: for if, when the ſpectrum is formed, you ſtill keep your eye fixed on the ſilk area, and remove it a few inches further from you, a green circle is ſeen round the red ſilk; for the angle now ſubtended by the ſilk is leſs than it was when the ſpectrum was formed, but that of the ſpectrum continues the ſame, and our imagination places them at the ſame diſtance. Thus when you view a ſpectrum on a ſheet of white paper, if you approach the paper to the eye, you may diminiſh it to a point; and if the paper is made to recede from the eye, the ſpectrum will appear magnified in proportion to the diſtance.

I was ſurpriſed, and agreeably amuſed, with the following experiment. I covered a paper about four inches ſquare with yellow, and with a pen filled with a blue colour wrote upon the middle of it the word BANKS in capitals, as in Fig. 5, and ſitting with my back to the ſun, fixed my eyes for a minute exactly on the center of the letter N in the middle of the word; after cloſing my eyes, and ſhading them ſomewhat with my hand, the word was diſtinctly ſeen in the ſpectrum in yellow letters on a blue field; and then, on opening my eyes on a yelloviſh wall at twenty feet diſtance, the magnified name of BANKS appeared written on the wall in golden characters.

Concluſion.

It was obſerved by the learned M. Sauvage (Noſol. Method. Cl. VIII. Ord. 1.) that the pulſations of the optic artery might be perceived by looking attentively on a white wall well illuminated. A kind of net-work, darker than the other parts of the wall, appears


BANKS



appears and vaniſhes alternately with every pulſation. This change of the colour of the wall he well aſcribes to the compreſſion of the retina by the diaſtole of the artery. The various colours produced in the eye by the preſſure of the finger, or by a ſtroke on it, as mentioned by Sir Iſaac Newton, ſeem likewiſe to originate from the unequal preſſure on various parts of the retina. Now as Sir Iſaac Newton has ſhewn, that all the different colours are reflected or tranſmitted by the laminæ of ſoap bubbles, or of air, according to their different thickneſs or thinneſs, is it not probable, that the effect of the activity of the retina may be to alter its thickneſs or thinneſs, ſo as better to adapt it to reflect or tranſmit the colours which ſtimulate it into action? May not muſcular fibres exiſt in the retina for this purpoſe, which may be leſs minute than the locomotive muſcles of microſcopic animals? May not theſe muſcular actions of the retina conſtitute the ſenſation of light and colours; and the voluntary repetitions of them, when the object is withdrawn, conſtitute our memory of them? And laſtly, may not the laws of the ſenſations of light, here inveſtigated, be applicable to all our other ſenſes, and much contribute to elucidate many phenomena of animal bodies both in their healthy and diſeaſed ſtate; and thus render this inveſtigation well worthy the attention of the phyſician, the metaphyſician, and the natural philoſopher?

November 1, 1785.

ADDITION.

ADDITION.

Additional Observations on VERTIGO, *which ought to have been inserted in Sect.* XX. 6. *after the Words* "optic nerve," *at the End of the second Paragraph.*

AFTER revolving with your eyes open till you become vertiginous, as soon as you cease to revolve, not only the circum-ambient objects appear to circulate round you in a direction contrary to that, in which you have been turning, but you are liable to roll your eyes forwards and backwards; as is well observed, and ingeniously demonstrated by Dr. Wells in a late publication on vision. The same occurs, if you revolve with your eyes closed, and open them immediately at the time of your ceasing to turn; and even during the whole time of revolving, as may be felt by your hand pressed lightly on your closed eyelids. To these movements of the eyes, of which he supposes the observer to be inconscious, Dr. Wells ascribes the apparent circumgyration of objects on ceasing to revolve.

The cause of thus turning our eyes forwards, and then back again, after our body is at rest, depends, I imagine, on the same circumstance, which induces us to follow the indistinct spectra, which are formed on one side of the center of the retina, when we observe them apparently on clouds, as described in Sect. XL. 2. 2.; and then not being able to gain a more distinct vision of them, we turn our eyes back, and again and again pursue the flying shade.

But

But this rolling of the eyes, after revolving till we become vertiginous, cannot cauſe the apparent circumgyration of objects, in a direction contrary to that in which we have been revolving, for the following reaſons. 1. Becauſe in purſuing a ſpectrum in the ſky, or on the ground, as above mentioned, we perceive no retrograde motions of objects. 2. Becauſe the apparent retrograde motions of objects, when we have revolved till we are vertiginous, continues much longer than the rolling of the eyes above deſcribed.

3. When we have revolved from right to left, the apparent motion of objects, when we ſtop, is from left to right; and when we have revolved from left to right, the apparent circulation of objects is from right to left; yet in both theſe caſes the eyes of the revolver are ſeen equally to roll forwards and backwards.

4. Becauſe this rolling of the eyes backwards and forwards takes place during our revolving, as may be perceived by the hand lightly preſſed on the cloſed eyelids, and therefore exiſts before the effect aſcribed to it.

And fifthly, I now come to relate an experiment, in which the rolling of the eyes does not take place at all after revolving, and yet the vertigo is more diſtreſſing than in the ſituations above mentioned. If any one looks ſteadily at a ſpot in the ceiling over his head, or indeed at his own finger held up high over his head, and in that ſituation turns round till he becomes giddy; and then ſtops, and looks horizontally; he now finds, that the apparent rotation of objects is from above downwards, or from below upwards; that is, that the apparent circulation of objects is now vertical inſtead of horizontal, making part of a circle round the axis of his eye; and this without any rolling of his eyeballs. The reaſon of there being no rolling of the eyeballs perceived after this

this experiment, is, becauſe the images of objects are formed in rotation round the axis of the eye, and not from one ſide to the other of the axis of it; ſo that, as the eyeball has not power to turn in its ſocket round its own axis, it cannot follow the apparent motions of theſe evaneſcent ſpectra, either before or after the body is at reſt. From all which arguments it is manifeſt, that theſe apparent retrograde gyrations of objects are not cauſed by the rolling of the eye-balls; firſt, becauſe no apparent retrogreſſion of objects is obſerved in other rollings of the eyes: ſecondly, becauſe the apparent retrogreſſion of objects continues many ſeconds after the rolling of the eyeballs ceaſes. Thirdly, becauſe the apparent retrogreſſion of objects is ſometimes one way, and ſometimes another, yet the rolling of the eyeballs is the ſame. Fourthly, becauſe the rolling of the eyeballs exiſts before the apparent retrograde motion of objects is obſerved; that is, before the revolving perſon ſtops. And fifthly, becauſe the apparent retrograde gyration of objects is produced, when there is no rolling of the eyeballs at all.

Doctor Wells imagines, that no ſpectra can be gained in the eye, if a perſon revolves with his eyelids cloſed, and thinks this a ſufficient argument againſt the opinion, that the apparent progreſſion of the ſpectra of light or colours in the eye can cauſe the apparent retrogreſſion of objects in the vertigo above deſcribed; but it is certain, when any perſon revolves in a light room with his eyes cloſed, that he nevertheleſs perceives differences of light both in quantity and colour through his eyelids, as he turns round; and readily gains ſpectra of thoſe differences. And theſe ſpectra are not very different except in vivacity from thoſe, which he acquires, when he revolves with uncloſed eyes, ſince if he then revolves very rapidly

the

the colours and forms of ſurrounding objects are as it were mixed together in his eye; as when the priſmatic colours are painted on a wheel, they appear white as they revolve. The truth of this is evinced by the ſtaggering or vertigo of men perfectly blind, when they turn round; which is not attended with apparent circulation of objects, but is a vertiginous diſorder of the ſenſe of touch. Blind men balance themſelves by their ſenſe of touch; which, being leſs adapted for perceiving ſmall deviations from their perpendicular, occaſions them to carry themſelves more erect in walking. This method of balancing themſelves by the direction of their preſſure againſt the floor, becomes diſordered by the unuſual mode of action in turning round, and they begin to loſe their perpendicularity, that is, they become vertiginous; but without any apparent circular motions of viſible objects.

It will appear from the following experiments, that the apparent progreſſion of the ocular ſpectra of light or colours is the cauſe of the apparent retrogreſſion of objects, after a perſon has revolved, till he is vertiginous.

Firſt, when a perſon turns round in a light room with his eyes open, but cloſes them before he ſtops, he will ſeem to be carried forwards in the direction he was turning for a ſhort time after he ſtops. But if he opens his eyes again, the objects before him inſtantly appear to move in a retrograde direction, and he loſes the ſenſation of being carried forwards. The ſame occurs if a perſon revolves in a light room with his eyes cloſed; when he ſtops, he ſeems to be for a time carried forward, if his eyes are ſtill cloſed; but the inſtant he opens them, the ſurrounding objects appear to move in retrograde gyration. From hence it may be concluded, that it is the ſenſation or imagination of our continuing to go forwards in the direction in which we were turning,

that

that cauſes the apparent retrograde circulation of objects.

Secondly, though there is an audible vertigo, as is known by the battèment, or undulations of ſound in the ears, which many vertiginous people experience; and though there is alſo a tangible vertigo, as when a blind perſon turns round, as mentioned above; yet as this circumgyration of objects is an hallucination or deception of the ſenſe of ſight, we are to look for the cauſe of our appearing to move forward, when we ſtop with our eyes cloſed after gyration, to ſome affection of this ſenſe. Now, thirdly, if the ſpectra formed in the eye during our rotation, continue to change, when we ſtand ſtill, like the ſpectra deſcribed in Sect. III. 3. 6. ſuch changes muſt ſuggeſt to us the idea or ſenſation of our ſtill continuing to turn round; as is the caſe, when we revolve in a light room, and cloſe our eyes before we ſtop. And laſtly, on opening our eyes in the ſituation above deſcribed, the objects we chance to view amid theſe changing ſpectra in the eye, muſt ſeem to move in a contrary direction; as the moon ſometimes appears to move retrograde, when ſwift-gliding clouds are paſſing forwards ſo much nearer the eye of the beholder.

To make obſervations on faint ocular ſpectra requires ſome degree of habit, and compoſure of mind, and even patience; ſome of thoſe deſcribed in Sect. XL. were found difficult to ſee, by many, who tried them; now it happens, that the mind, during the confuſion of vertigo, when all the other irritative tribes of motion, as well as thoſe of viſion, are in ſome degree diſturbed, together with the fear of falling, is in a very unfit ſtate for the contemplation of ſuch weak ſenſations, as are occaſioned by faint ocular ſpectra. Yet after frequently revolving, both with my eyes cloſed, and with them open, and attending to the ſpectra remaining

in

in them, by ſhading the light from my eyelids more or leſs with my hand, I at length ceaſed to have the idea of going forward, after I ſtopped with my eyes cloſed; and ſaw changing ſpectra in my eyes, which ſeemed to move, as it were, over the field of viſion; till at length, by repeated trials on ſunny days, I perſuaded myſelf, on opening my eyes, after revolving ſome time, on a ſhelf of gilded books in my library, that I could perceive the ſpectra in my eyes move forwards over one or two of the books, like the vapours in the air of a ſummer's day; and could ſo far undeceive myſelf, as to perceive the books to ſtand ſtill. After more trials I ſometimes brought myſelf to believe, that I ſaw changing ſpectra of lights and ſhades moving in my eyes, after turning round for ſome time, but did not imagine either the ſpectra or the objects to be in a ſtate of gyration. I ſpeak, however, with diffidence of theſe facts, as I could not always make the experiments ſucceed, when there was not a ſtrong light in my room, or when my eyes were not in the moſt proper ſtate for ſuch obſervations.

The ingenious and learned M. Sauvage has mentioned other theories to account for the apparent circumgyration of objects in vertiginous people. As the retrograde motions of the particles of blood in the optic arteries, by ſpaſm, or by fear, as is ſeen in the tails of tadpoles, and membranes between the fingers of frogs. Another cauſe he thinks may be from the librations to one ſide, and to the other, of the cryſtalline lens in the eye, by means of involuntary actions of the muſcles, which conſtitute the ciliary proceſs. Both theſe theories lie under the ſame objection as that of Dr. Wells before mentioned; namely, that the apparent motions of objects, after the obſerver has revolved for ſome time, ſhould appear to vibrate this way and that; and not

to circulate uniformly in a direction contrary to that, in which the obſerver had revolved.

M. Sauvage has, laſtly, mentioned the theory of colours left in the eye, which he has termed impreſſions on the retina. He ſays, "Experience teaches us, that impreſſions made on the retina by a viſible object remain ſome ſeconds after the object is removed; as appears from the circle of fire which we ſee, when a fire-ſtick is whirled round in the dark; therefore when we are carried round our own axis in a circle, we undergo a temporary vertigo, when we ſtop; becauſe the impreſſions of the circumjacent objects remain for a time afterwards on the retina." Noſolog. Method. Claſ. VIII. 1. 1. We have before obſerved, that the changes of theſe colours remaining in the eye, evinces them to be motions of the fine terminations of the retina, and not impreſſions on it; as impreſſions on a paſſive ſubſtance muſt either remain, or ceaſe intirely. See an additional note at the end of the ſecond volume.

Dum, Liber! aſtra petis volitans trepidantibus aliis,
Irruis immemori, parvula gutta, mari.
Me quoque, me currente rotâ revolubilis ætas
Volverit in tenebras,—i, Liber, ipſe ſequor.

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END OF THE FIRST VOLUME.